AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Executive Office of the Society: Saint Joseph, Michigan.

ARNOLD P. YERKES, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 18 NOVEMBER 1937 NUMBER 11

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Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the executive office of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . . The title AGRICULTURAL ENGINEERING is registered in U. S. Patent Office. Copyright, 1937, by American Society of Agricultural Engineers.

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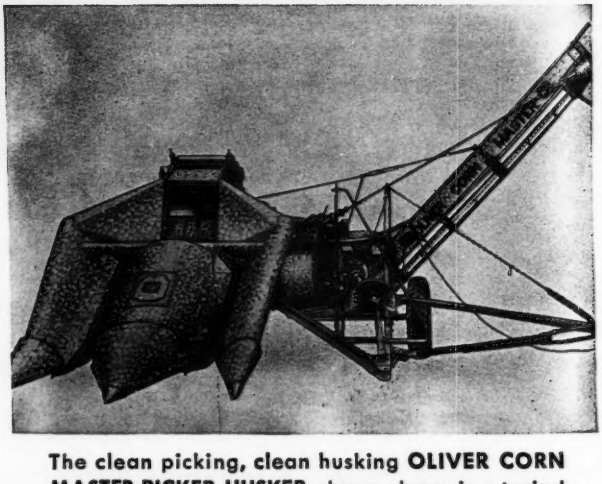

The clean picking, clean husking **OLIVER CORN MASTER PICKER-HUSKER,** shown above, is a typical example of the wide variety of tractors and farm machinery served by Hyatts.

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AGRICULTURAL ENGINEERING

VOL 18, NO 11 EDITORIALS NOVEMBER 1937

Broadened Foundations

ENGINEERING, as an applied phase of the physical sciences, has developed along with those sciences. In fact, the theoretical and applied phases have helped each other in many ways. Engineering has uncovered new phenomena and new leads to knowledge in pure science. They have been mutually supporting.

As theoretical physics and chemistry have advanced in refinement and detailed knowledge of the nature and behavior of forces and materials, engineering has found new practical use for at least some of the new knowledge.

For years the range of science upon which engineering was based remained relatively fixed. It was largely inorganic, the secrets of living forces and materials seeming too unrelated and not sufficiently unravelled by science to offer promise of engineering control and application.

But now the basic science in which engineering is founded is expanding. Its range is extending farther and farther into the formidable field of biology. In addition to organic chemists there are biochemists, biophysicists and other specialized scientists studying the matter and energy relationship of living organisms. Their studies have narrowed the apparent gap between organic and inorganic organization of molecules. Electrical forces have been identified in living organisms, not only as static charges on the surface of living matter, but as forces within the cell essential to its life and functions.

Does all this mean a broader scientific foundation for engineering? Can engineering utilize a broader range of science? Can engineers keep in step with theoretical physicists and chemists in this widening of what has been their common field of science? Can they be as mutually supporting and helpful in the new portion of this field as they were in the old? Or must these scientists seek new contemporaries to advance the application phases of biophysics and biochemistry, and to reflect back resulting leads to new knowledge in the pure sciences?

We ask in all sincerity and with open minds. Agriculture, being an industry of biologic production—an industry involving organic physical, chemical, and energy transformations of staggering proportions—seems a logical prospect to profit from applied biophysics and biochemistry.

True agricultural engineers would not stand in the way of this opportunity for benefit to agriculture. If they cannot make these applications themselves, they will undoubtedly stand back and clear the way for whoever can. Moreover, they will stand ready to help in whatever way their knowledge of engineering and agriculture may make possible.

But there are indications that some agricultural engineers, with their foundation knowledge of biologic science, as well as of practical farming, in addition to their engineering fundamentals, may be better qualified than anyone else to lead the way in the application of biophysics and biochemistry to agriculture.

That being the case, they will be guilty of neglect of a professional obligation if they fail to follow up their opportunities aggressively on behalf of agriculture, of the pure science concerned, of the engineering profession, and their own branch thereof.

By being aggressive in this new field, we mean fraternizing with the scientists concerned and suggesting to them some lines of knowledge that would help agriculture. What is the ideal combination and condition of raw materials, energy supply, and environment for the biological chemical-processing plants commonly called alfalfa, corn, hogs, and steers? What do you know about them that we could use? And the working conditions of the biological milk factory and egg factory! What should they be? These scientists might be found cordially responsive to an attitude, on the part of agricultural engineers, of saying, "We find that this influence produces such-and-such effect of possible agricultural significance. We would like to learn the cause, if possible; the detailed forces and reactions involved; the limiting conditions and means of control, as a sound basis on which to develop practical agricultural engineering applications."

The broadening of their foundation science seems to be a direct challenge to agricultural engineers, above all others. We believe they can measure up to this new opportunity.

Farm Structures Progress

K. J. T. EKBLAW, in his paper published elsewhere in this issue, suggests further organization of farm building interests as a basis for active progress. He has pointed out that for most rapid progress "engineering, research, extension, production, and distribution should go hand in hand." When they do not, one lagging element will delay realization of the objective of actual improvement in the buildings on farms. An organization embodying all of these elements is the only force equal to boosting along any lagging ones and keeping them all working together.

There are numerous organizations each already occupying part of the field. Their efforts need coordination. As we see it, the kind of organization that could do the coordinating would be analogous to the Committee on Relation of Electricity to Agriculture, in the rural electrification field.

Agricultural engineers in public service will agree on the objective of achieving better farm buildings. Mr. Ekblaw has indicated that the commercial interests agree in principle with the idea of better organization. All will agree that farmers are losing money daily due to the lack of adequate buildings and building maintenance; and that the building materials and equipment interests are missing opportunities in a sound, economically justified market.

The time seems ripe for following up Mr. Ekblaw's suggestion. If an organization can be worked out which would merit and hold the needed widespread support, the time to develop it may be now. It may be worth trying.

An Experiment in Meeting Efficiency

FOLLOWING the meeting of the American Society of Agricultural Engineers at Chicago last December, several constructive suggestions were made for meetings of shorter duration. Aside from the personal expense of a prolonged stay in Chicago, many men interested in the programs of two or more technical divisions find it difficult or impossible to be away from their work for the better part of a week at that time of the year. It was also suggested that greater contact opportunities would result from having all the divisions meeting at the same time.

In the past, from four to six hours of each meeting day have been utilized for technical sessions, committee meetings, and group round tables. Some of the remaining twenty-four hours have been used by some of those attending in making desirable informal contacts. But following the sessions, the crowd has separated to an extent that made it difficult for individuals to find each other for desired conversations.

One promising proposal for better use of time suggested staggered two-hour sessions of the divisions, running throughout the day from 9:00 a.m. to 5:00 p.m. An adaptation of this plan is scheduled for trial on Wednesday, December 1, the second day of the fall meeting this year.

It will bring together for this one day the full attendance of all four divisions. It will shorten the meeting from four to three days. The Power and Machinery Division has been paired off with the Farm Structures Division, and the Rural Electric with the Soil and Water Conservation Division, for simultaneous sessions. It is believed that, simultaneous sessions being unavoidable, this pairing will result in the fewest possible cases of men wanting to hear two papers that are being presented in different rooms at the same time. The machinery and structures groups will start off the morning and afternoon, and be followed, in both the morning and afternoon, by the other two divisions, meeting in the same rooms, after an intermission just long enough to change audiences.

Under this arrangement there will be two hours between successive sessions of the same division. The individual interested primarily in the program of any one division has the freedom of several alternatives during the time that division is not in session. He may sit in on the meeting of either of two other divisions, talk informally with whomever he chooses who is not in one of the meetings, eat his lunch, attend to other business in the city, or otherwise suit his taste and convenience. That range of choice, combined with the other advantages mentioned, might be expected to come as near as possible to satisfying everyone.

Operation of the plan will require opening and closing of sessions on schedule, and cooperation of the audience in changing rooms promptly to keep up with their individual schedule. This requirement that individuals conduct themselves in a businesslike manner may not prove too much of a burden to the engineers attending, in consideration of the advantages to be gained.

An Adequate Philosophy

YOUNG agricultural engineers seeking adequate wording for a philosophy justifying their choice of a life work, may find it in the paper on "Mechanized Agriculture and Civilization," by Harold E. Pinches, reviewed elsewhere in this issue.

The philosophy that civilization flourishes in an atmosphere of well-used leisure and security—rather than from the privation and adversity which seem to have emphasized the greatness of some historic individuals and races, while crushing uncounted others into oblivion—supplies the supreme justification of all effort at technological progress.

Engineering is shown to be a major application of technology contributing to increased leisure and security.

Agriculture is shown as a tremendous field of opportunity for the application of technology, including engineering, to further increase leisure and security.

The tie-up is complete. In this light agricultural engineering offers truly great opportunity to contribute substantially to the progress of civilization, notwithstanding the existing factors tending to delay or reverse such progress. What broader, more fundamental, or more satisfying philosophy could man want?

Experimental Line Building

EVERY farmer in Racine County, Wisconsin, who has applied for electric service now has it, according to R. E. Moody, vice-president of the Wisconsin Gas and Electric Company, quoted in a Racine daily paper.

This has been made possible by a liberal and progressive line-extension policy adopted by the company for the area it serves. The minimum rate is $4 per month for 80 kwh and all additional current used is on a rate of 2.5 cents per kilowatt-hour.

Mr. Moody is further quoted as saying "If it is not widely used for motor operation, water pumping, milking machines, silo filling, wood sawing, refrigeration, and similar purposes, the electrification experiment will prove unsuccessful." We hesitate to accept, however, the possible implication that the company has made its extensive investment in service lines on any blind faith that availability and low cost of current alone will promote extensive farm use of electricity. That has been disproved too often.

It is easier to believe that this utility has carefully laid plans to encourage and assist its farm users to make profitable use of enough current to insure the success of the "experiment." The days of experimenting in rural electrification are or should be past, so far as the word applies to extending lines into the country, hooking on a few farms, and waiting to see what will happen.

The price of increasing farm use of electricity is continuous agricultural engineering assistance to farmers in making full use of whatever electrical equipment they may have acquired, and in selecting and applying additional equipment according to the needs, opportunities, and capacities of individual farms and farmers to use it profitably. To any utility investing money in farm distribution lines we commend a proportionate investment in agricultural engineering service to complete the set-up for farm current consumption and income to the utility. A farm distribution set-up without agricultural engineering service is scarcely more complete than a pole line without wires.

Air Conditioning of Farm Buildings

By F. L. Fairbanks

AT PRESENT we cannot too often attempt to define air conditioning, for most people, not engineers of course, have a very blurred picture of what air conditioning is.

The 1937 ASHVE "Guide" states: "Air conditioning has for its objective the supplying and maintaining, in a room or other enclosure, of an atmosphere having a composition, temperature, humidity, and motion which will produce desired effects upon the occupants of the room or upon materials stored or handled in it."

This is a good definition and should be perfectly understood by all who read. We might, however, add the word "purity", since in our work with animals the idea of pure air may well be retained.

When A. M. Goodman and I started our work in dairy stable ventilation (that was what we called it then and still do although the term is not correct), I worked at first with two thoughts in mind—air change and moisture removal. This was not entirely satisfactory for the dairy stable.

Presented before a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Toronto, Canada, October 12, 1937.

Author: Professor of agricultural engineering, and agricultural engineer in the experiment station, Cornell University. Mem. ASAE.

It gradually became evident that since I was not satisfied, I had better try to find what to do about it. We have found out some things and I do not hesitate today to say that we are air conditioning animal shelters.

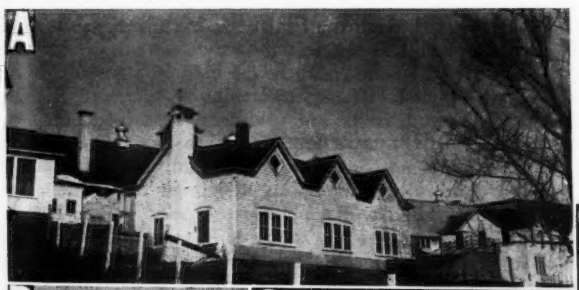
You do not always have to have a mechanical heating system or a mechanical refrigerating system to air condition an animal shelter. You can do it with animal heat, insulation, and a properly designed ventilation system.

Maybe you would like to know if I can defend this last statement. There was a time when I would have said that this would be a long story with too many details to attempt to answer the question in a paper such as this. Today, however, I think I can answer it. As a matter of fact, I have answered it when I say that we do it by properly using animal heat, by the insulation and construction of the shelter, and a ventilation system. In a little more detail my defense is as follows:

1 Keep in mind what air conditioning is and that we are really air conditioning the animal shelter.

2 You will recall that the first item of control stated in the definition was air composition, or you may call it purity. This is controlled by size of outtakes and intakes, the location and design of outtakes and intakes, and the wall construction.

3 The next item is temperature control. This is ac-



(A) Air-conditioned calf barn, 22x49 ft, eleven pens; capacity 24 calves one week to four months of age. (B) Outtake flue and furnace intake. (C) All incoming air enters the stable through the hot air furnace. (D) Closed duct leading from furnace to distributing trough. (E) Incoming air distribution trough above central alleyway

complished through design of outtakes and intakes, wall and ceiling construction, and animal heat.

4 Another item is humidity control. This is influenced by the design of the ventilation system, the wall and ceiling construction, and the animal heat and moisture production.

5 The last, air motion within the air-conditioned space, is controlled by the design of the ventilation system, the wall and ceiling construction, and the animal heat distribution.

Of course, there are cases where mechanical heat is necessary to obtain the desired results, but in a great many cases it is not essential.

Many of you are familiar with our dairy stable ventilation system and know how we control the conditions in the stable. The same principles on which this system is based apply to all farm buildings.

Quite a number of men in the North Atlantic area have been working with this problem of air conditioning. We have all felt, I believe, the need for recommendations as to air requirements of farm animals and storage crops. This includes composition, temperature, and humidity of the air. You will notice that I have left off air movement. That is our problem. The others—temperature, composition, and humidity requirements—are the animal and crop men's problems.

Some progress has been made by agricultural engineers in developing and carrying through cooperative projects on these subjects, and it is safe to say that dairy stables, poultry houses, apple storages, and potato storages are pretty well cared for, although more work may well be done on the air requirements of animals and crops. The farm home is not so much of a problem, but it too should be air conditioned.

We do have approximate values now for some animals and crops as follows:

	Air flow, cfm	Temperature, degrees Fahrenheit	Relative humidity, per cent
Dairy cattle	60 per head	45 — 60	75 — 80
Calves	15 per head	50 — 60	40 — 60
Hens	1 per hen	20 — 50	50 — 90
Apples	0	30 — 32	80 — 85
Potatoes	0	37 — 40	90
Cabbage	0	32 — 40	90 — 98
Squash	0	40	50 — 70

You will note that the air flow is given as zero for apples, potatoes, cabbage, and squash. Provision should be made for airing out these storages at certain times, but a continuous air flow is not desirable.

These values are important to us in our design of the air-conditioning system, and these are the values that the animal and plant men should give us.

It is our job, however, to design or modify the building and to provide suitable equipment to install in the building so that air conditioning is accomplished.

I feel that as agricultural engineers it is our opportunity to clarify the terms "ventilation" and "air conditioning." One good reason is that the animal and plant men are apt to and have designed their own buildings and ventilation equipment. In many cases these have failed to provide the desired results.

I have talked with some of these men, and they have told me that some of the simplest fundamental things that I have suggested to them will not work. When you experience such a situation and know that you have proof and can demonstrate the soundness of your recommendations, you begin to realize that the difficulty is due to a lack of knowledge of the fundamental engineering principles involved.

Let's put ventilation in the background and still use it as one of the tools with which we work. Let's not give so much publicity to ventilation of farm buildings.

But let's put the emphasis on air conditioning. Let's explain clearly what air conditioning is, and we will then have more than we can do in this field. Most important of all, our farms will have buildings so equipped that they will last longer, be better places for man to work in, be more healthful for the livestock, and serve as the most economical and efficient equipment with which the farmer works.

That may sound like exaggeration, but you must bear in mind that we are saving the farmer money, we are making his buildings more foolproof, we are eliminating to quite a degree the effects of weather changes on the stock, and we are doing this in some ways strange to the usual heating, ventilating, and air-conditioning practices today.

I should like to tell you about one of these ways of air conditioning a calf barn. This was a pen barn with only a central alley, the pens on each side extending to the wall. The walls were heavily insulated and tight, and storm windows were used. I put up a single-floor flue for the outtake, then came the problem of how to get the air into this stable.

The owners wanted to maintain a temperature of 60 F in the stable, and this barn was in a part of New York State where zero weather is common during the winter. A hot air furnace had already been installed in the stable to recirculate the air.

I did not like to have zero air dropping into any part of the stable; in other words, I wanted to temper this air as it came in. That could be done easily by bringing the incoming air through the furnace and into the stable. The distribution of this hot incoming air was simple, but the hitch came when the weather was mild enough so that no fire was needed. Then how could I distribute the air without causing drafts and cold spots in the stable.

The result of my efforts was a trough closed on the sides and one end. This trough was hung from the ceiling in the center alley and ran the length of the stable. The top of the trough was 2 in from the ceiling. The bottom of this trough sloped upward from the entering end to the closed end, to retard the horizontal flow of cold air.

When warm air enters the trough it naturally flows along the trough, rising and flowing out on each side. When cold air enters the trough it flows in until the trough is filled and then spills over the sides, falling gently into the center alley. Thus, I was able to get a uniform distribution of both warm and cold air, without drafts or cold spots in the stable.

It seems to me that that comes pretty close to air conditioning. We controlled the composition of the air, the temperature, the humidity (the air was humidified as it passed through the furnace), and the air movement.

I think we should realize that as engineers we have the engineering facts which enable us now to air condition some farm buildings. We need, however, to know more about the environment requirements of farm animals and crops.

Much has been done through the cooperation of engineering and medicine to determine the desirable environmental requirements of man. We can also cooperate with the animal and plant scientists and medicine, to dig out the environmental requirements of farm animals and crops. Let us do this, and at the same time make use of the information that we now have to put air conditioning of farm buildings in its true relation to the farm business.

Mechanical Methods of Water Conservation on Pasture and Range Land

By Paul C. McGrew

MECHANICAL methods of water conservation are not new, but there has been no wide application of them on pasture and range lands until the last three or four years. In areas of low rainfall, the conservation of moisture is particularly important. The importance of moisture conservation, however, is not limited to the areas of low rainfall, but also includes some of the more humid areas. At the present time mechanical methods of water conservation are in use in nearly all parts of the country. Some of the principal mechanical methods of water conservation used on pasture and range lands include contour furrows, diversion dams, flood irrigation, water spreading, dams to raise the ground water table, and stock water dams.

Contour Furrowing. Contour furrowing is probably more widely used as a moisture conservation practice for pasture and range land than any other mechanical method. This type of work has been done in nearly all parts of the country, but especially in the Great Plains states. Contour furrowing can be described as including level furrows on pasture, range, woodland, or other lands not having annual cultivation.

The results of investigations by the ASAE Subcommittee on Contour Furrowing (1936-37 report)[1] indicate that for best moisture distribution a large number of small furrows closely spaced was preferable to larger furrows with a wider spacing. A horizontal spacing of 15 to 20 ft is common when using a single-furrow type of implement such as a plow or special furrowing machine, while a closer spacing is common when using a lister. In some areas larger furrows have been used with horizontal spacings from 25 to 60 ft. These larger furrows are effective for flood control but do not give as favorable moisture distribution. The recommendations from most sections are that the furrows should be designed to hold from ¾ to 1 in of runoff, although there are numerous instances where lesser or greater amounts of runoff have been provided for.

Throughout the Great Plains area, most of the furrows have been on slopes of less than 10 per cent, with 1 to 3 per cent slopes common in many cases. In the Mississippi Valley and some of the eastern states, furrows have been constructed on slopes up to about 20 per cent, while in the Pacific Northwest furrows have been constructed on slopes up to 40 per cent.

Nearly all types of implements that make furrows have been used for contour furrowing. Single-bottom moldboard or disk plows are used to turn the furrow either upslope or downslope. The lister is also commonly used, the three-row lister with the center unit removed being preferred in some areas. Special furrowing machines have been constructed in several places. In the sod grass area of Kansas, a machine has been used which will lift the sod and place it grass-side-up at the side and about 6 in away from the furrow. Where this work has been done during the period when the sod was dormant, the grass has continued to grow on the furrow slice. In Idaho a heavy, 22-in brush breaker plow (Fig. 1) operating at a depth of 10 to 12 in has proved successful in making large furrows. The plow has an extension moldboard and a special attachment which forms dams in the furrow. The damming attachment is operated hydraulically from the seat of the tractor, so that the furrow and dams are completed in one trip. Dams at intervals of 25 to 100 ft are desirable in all types of furrows, as this tends to prevent concentration of water at low places and gives a better distribution of moisture.

In constructing furrows, as little vegetative cover should be destroyed as possible and the work should be conducted in a manner which will provide for early reestablishment

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 24, 1937.

Author: Associate regional conservator (Region 11), Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

[1]Final Report for 1936-37, ASAE Subcommittee on Contour Furrowing.

FIG. 1 (LEFT) BRUSH-BREAKER PLOW EQUIPPED WITH EXTENSION MOLDBOARD AND DAM-FORMING ATTACHMENT. FIG. 2 (RIGHT) CONTOUR FURROWS ON WATERSHED ABOVE POCATELLO, IDAHO

of vegetation on the disturbed area. For this reason the practice in some areas has been to break and spread the furrow slice so it will not smother the vegetation. This method does not spread the water over as wide an area as where the ridge is used, but the furrow is less likely to break when the capacity is exceeded, so the method has certain advantages.

Outstanding results have been reported showing benefits of moisture conservation, increased vegetative growth, erosion control, and flood control. In the southern Great Plains[1], an area was furrowed with a two-row lister with the wings removed and the sides of the points cut off so as to leave them only 6 in wide. The furrows were made 4 in deep, 6 in wide, and 44 in apart, with about 20 ft between adjacent pairs of furrows. The furrowing was done in June. In September the moisture penetration was 28 in in the furrow and 9 in on the undisturbed land between furrows. A similar untreated pasture having comparable soil, slope, and rainfall had an average moisture penetration of 10 in. The furrowed pasture produced 90 per cent more grass than the unfurrowed area and twice the amount of grama grass seed.

Contour furrows were constructed in Idaho in a watershed above a city (Fig. 2). These furrows were primarily for flood control. Within a year after construction was started, there was a rain of 2.03 in, 1.3 in falling in one hour, with most of this in a 30-min period. The contour furrows were successful in preventing a flood on the portion of the watershed which had been completed. On an adjacent small watershed runoff was heavy, carrying debris into the city, and washing out a short section of a street to a depth of 8 ft. The moisture penetration three days after the rain was 7 to 10 in on the undisturbed area between furrows and 16 to 24 in in the furrow.

Diversion Dams for Flood Irrigation. There are many opportunities throughout the Great Plains area to conserve water by a system of diversion dams for flood irrigation. Most of the area is subject to intense summer rains which result in a quick runoff. A method which has been successfully used in several states during the past few years consists of the construction of a dam across the gully or channel, thus diverting the water to the land on one or both sides. Diversion dykes are constructed to distribute the water and to prevent the water from flowing back into the channel below the dam. The number of dykes and amount of distribution system needed will vary with the topography, and the dam should be constructed in as favorable a location as possible. It is important that these areas be carefully surveyed and proper provision be made to handle the flow without danger to the dam. It is sometimes possible to carry the water several thousand feet, and frequently all the runoff is absorbed instead of its rushing wildly down the gully. The acreage to be irrigated will vary with the topography and amount of runoff. Areas from five to several hundred acres have been reported. This type of flood irrigation is reported to have been used by the early Indians, although they depended mostly on natural conditions and selected their fields accordingly rather than attempting to construct large dams or dykes.

We have observed excellent examples where the native grasses were green and showed improved vigor on land which had received flood irrigation, as compared to dried-up grass on similar adjacent land outside the area of flood irrigation. In other cases, the flood waters were used to irrigate alfalfa fields, thus providing supplemental feed for the winter. This additional forage production is of direct benefit to the range because it will provide feed for stock during periods in which they should be kept off the range. In addition to the benefits of increased production, there are flood control and erosion control benefits which in some areas are of equal or greater importance.

Water Spreading. The practice of water spreading as considered in this discussion refers to the methods of diverting water over pasture and range lands for obtaining better utilization of precipitation. This practice is quite similar to flood irrigation and might have been discussed under this head, except that the term "water spreading" has become quite generally used in several areas. There are other phases of water spreading which include the artificial application of water to lands for the purpose of storing it in the ground for subsequent withdrawal by pumps, but this practice is not included in discussing the application to pasture and range land.

There are several factors which must be considered in planning for water spreading. There must be water available to spread periodically, the topography must be suitable, and the soil and vegetative cover must be such as will permit the application of additional water without erosion damage. The water may be collected by a diversion ditch or intercepting dyke and is released in small amounts at points where it is desired to spread water. Short contour furrows are frequently used in connection with water spreading, either in connection with the diversion ditch or independently. When an upper furrow is full, the water flows out of the ends and perhaps over the ridge and trickles down the slope to the next furrow, the center of which is directly below the gap (open ends) in the furrow above. This system, when properly planned, keeps the water spread over the slope and holds it on the slope long enough to permit absorption.

Check Dams to Raise Ground Water. There are many places where deep gullies have been cut through valley floors, thus lowering the water table. This has sometimes changed the area from an excellent pasture or meadow, which stayed green throughout the summer season, to an area dependent upon periodic showers and perhaps but little better than the sloping hill land. One example of the effect of lowering the ground water was recently brought to my attention. A valley bottom had been cropped to alfalfa and produced three cuttings a year. About 10 years ago a small channel through the center of this valley started eroding rapidly. At the present time there is a gully 20 to 30 ft deep. The alfalfa production has dropped to one good cutting. The second cutting is uncertain and is dependent upon seasonal rains. This gully extends several miles, and it is well established that the reduction in yield is the result of lowering the ground water.

A possible solution in such cases is to raise the bottom elevation of the gully, thus bringing the water table to within reach of the perennial plants. This may be accomplished by a series of well-constructed check dams of proper height and spacing, or possibly over a longer period it may be accomplished by tree planting. In either case a program of watershed protection should be carried out at the same time. The reestablishment of a shallow stabilized channel thus permits the conservation of the moisture in the ground for plant growth rather than draining it into a deep channel out of the reach of plants.

Stock Water Dams. On many range and pasture lands, the water supply for stock is an important problem which may frequently be solved by properly constructed stock-watering ponds. In designing the pond, it is important that there be sufficient storage to insure water during periods of drought. The depth *(Continued on page 491)*

Stream Bank Protection

By I. L. Saveson and Virgil Overholt

STREAM bank cutting is one of the many erosion problems confronting agricultural engineers. This problem is especially prevalent on intermittent streams that are bordered by valuable bottom lands. Such streams in Ohio generally have watersheds of from 10 to 30 square miles, these watersheds being steep and having flash runoff. The streams also are of very flat gradient; they rise quickly after heavy rains, often overflowing their banks after a single rain.

These streams are eating back into valuable bottom lands, laying them waste and covering them with gravel bars. On one stream in Ohio on a large sweeping curve, the stream cut back into a farmer's field from 16 to 30 feet during the 1937 spring flood.

In November 1935, a reconnaissance survey was made of the work areas of the 19 CCC camps operating under the jurisdiction of the U. S. Soil Conservation Service in Ohio. This survey covered 17,559 square miles, and showed 1,765 miles of streams with bank cutting that endangered 127,010 acres. Based on local land values, the land endangered had a value at that time of $6,482,900. Farmers realize this problem. Engineers of the state agricultural extension services and the Soil Conservation Service receive many requests for information and methods of control that can be used in curbing this menace. They hear from farmers many times, "I have a stream on my farm that is eating back into my good bottom field. How can I control it?"

Stream-bank erosion also materially affects land use. It is definitely agreed that good land use calls for cultivation of the flatter lands and the retirement of the steeper land to pasture and trees. If the present condition is allowed to continue uncontrolled, with the consequent wasting of the farmer's good bottom land, the farmer is going to be forced to cultivate his steeper lands and thereby increase erosion and runoff.

Since this type of erosion has a direct bearing on land use, it was felt that demonstrations of methods to curb it should be included in the Soil Conservation Service work program.

Upon investigation, there was found little available data which were adaptable or would afford light on a simple, efficient method of control. The situation clearly required a study of stream-channel behavior and control of small streams, particularly of streams having watersheds with a flash runoff, in order to ascertain an indication of channel behavior so that a logical, economical, practical, and effective means of control could be developed. The Ohio State University and the Soil Conservation Service cooperated in making the study since both agencies desired the information.

The study resolved itself into the following phases:

1 Field observations of the problem
2 Review of available information
3 Model studies, conclusions, and recommendations
4 Follow-up field observations of controls developed.

Field Observations. Streams, in seeking their hydraulic gradient, have a tendency to meander, and the outside of the curves they make become subject to erosion. Increased velocity at the outside of the curve causes the stream to carry away the soil and deposit it at the inside of the curves farther downstream, the velocity at these points being insufficient to transport the stream load. This process causes a steep bank on the outside of the curve, which is being undercut, and the upper portion caves and sloughs off. This soil is soon washed away, leaving no opportunity for the bank to reform to a sufficiently flat slope to maintain vegetation. On the inside of the curve there is generally a long, sloping gravel and sand bar on which undesirable vegetation establishes itself. This is more or less a "shoving" process that forces the stream into bordering bottom land.

The rate of this process of erosion and deposition is influenced by several factors. Sandy, gravelly soil tends to erode much faster than heavy, clay soil. Many stream

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 22, 1937.

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(LEFT) MEANDERING STREAM DAMAGING VALUABLE BOTTOM LANDS. (RIGHT) STREAM BEND WITH DEFLECTORS INSTALLED DURING THE SPRING OF 1936 AND PLANTED DURING THE SPRING OF 1937. THE GRASSES VISIBLE SURVIVED THE 1937 FLOOD

banks in Ohio have a seam of pure gravel approximately 2 feet above the normal flow line, which is washed out readily, allowing the upper portion to cave in. This is especially true during freezing and thawing weather.

Vegetation, or lack of it, plays an important part in the rate of erosion of stream banks. Erosion is most serious where farmers have cleared the banks of trees in order to prevent shading of their crops and to utilize their bottom land to the fullest extent. A good stand of willows, cottonwood, sycamore or black locust in many instances holds the outside bank of a stream and prevents it from eroding. However, once a bank has begun to erode, it is difficult, without some structural aid, to get started a growth that is sufficient to protect the bank. Vegetation growing on the inside of the curve of a gravel bar frequently tends to increase the rate at which the channel moves toward the outside curve. Willow can be one of the greatest assets in controlling erosion, if properly placed and of the right species. White and black willow are the best since they grow into trees and do not shed their limbs. This shedding is characteristic of the crack and bar willow, the limbs of which float downstream and lodge in locations where their growth is undesirable. The white willow forms a mat of roots that protects the bank from eroding.

Review of Information. A search of the engineering and main libraries of Ohio State University for information pertaining to bank protection on small streams disclosed little information of value. Practically all of the work done was on larger rivers such as the Ohio, Missouri, and Mississippi. Mats woven of brush, poles, and cable have been used; dykes constructed of huge mounds of rock placed at right angles to the bank have also been used. However, practically none of these structures were for bank protection, but were used to keep the channel scoured open for navigation and flood control.

A model study was made in Berlin, Germany, in the latter part of the nineteenth century for the purpose of studying the silting of stream channels and the scouring effect of dykes, the main interest being in the maintenance of navigable streams.

Model Studies. A model was installed in the agricultural engineering department of the Ohio State University to study some of the fundamental principles of channel behavior and bank cutting, to serve as a guide in the design of control structures, and also to try the effectiveness of certain types of control structures before installing them in the field.

This model consisted of a tank measuring 8x30x1½ feet, pivoted in the center on a fulcrum. The corners were mounted on screw jacks to facilitate tilting the tank and to alter the grade of the channel of any stream constructed in it. A stilling basin was installed at each end of the tank, one for receiving the discharge from the pump; and the other for gaging purposes, equipped with a weir and hook gage. An outlet was connected to the last basin to return the water to a pumping cistern. A vertical centrifugal pump was used for circulating the water. The pump was installed in the cistern. It pumped the water into the first basin, where it was allowed to run by gravity into the upper end of the model channel through which it flowed to the second basin, whence it returned to the cistern.

The tank was filled with river bottom soil and packed. However, no effort was made to reproduce soil profile, since we were not interested in a quantitative comparison between the field and the model. Our main interest was to secure comparative data under equal conditions, which would give us an indication of channel behavior, using this indication as a guide in the design of control structures.

Problem streams were surveyed in the field, cross sectioned every 100 feet, and reproduced in the model for study. These streams were reproduced on a scale of 1 foot equals 40 feet on the horizontal, and 1 foot equals 15 feet on the vertical. The exaggerated vertical scale was deemed necessary to secure velocities somewhere near field conditions.

All streams in the model were reproduced without the sand bars. The sand bars were allowed to form by turning on the water in the channel and feeding sand at the upper end by means of a sand agitator. The agitator consisted of a box with sloping sides mounted on four legs. The bottom was covered with No. 8 mesh wire screen. A frame with a handle attached was set over the screen wire and extended to the outside of the box to enable the operator to sift sand into the stream. These experimental bars were formed in a manner identical with the mode of formation in the field.

In order to measure and record the results a profilometer was used. The stream was cross-sectioned at the hubs set in the model in accordance with the field survey. This device consisted of a series of ¼-inch dowel pins set in slots on 1-inch centers in a wooden frame, with a clamping device consisting of wing nuts approximately 6 inches apart.

The profilometer was placed on the two hub stakes and the clamps loosened, allowing the pins to align themselves in accordance with the cross section of the channel. This cross section was plotted directly by placing the profilometer on cross-section paper and marking the points. Cross sections were superimposed, using different colored pencils for each test. The areas of cross sections, showing the amount of sand bar cutting, deposition, and bank cutting were planimetered, and the area recorded in square inches. Graphs of the various areas were plotted to give a comparative analysis of the results of each test run.

In summing up observations from the field, it was assumed that some type of deflector and vegetation could be used in controlling erosion. It was further assumed that deflectors should serve a threefold purpose:

1 Stop bank cutting.

2 Cause deposition of silt along the steep bank which would provide a planting bed for willows and other vegetation.

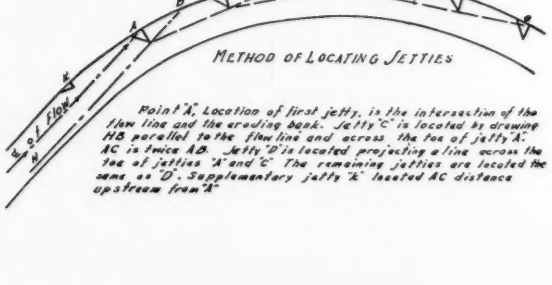
3 Remove all or part of the gravel bar, thereby forcing the flow line toward the middle of the channel away from the steep bank.

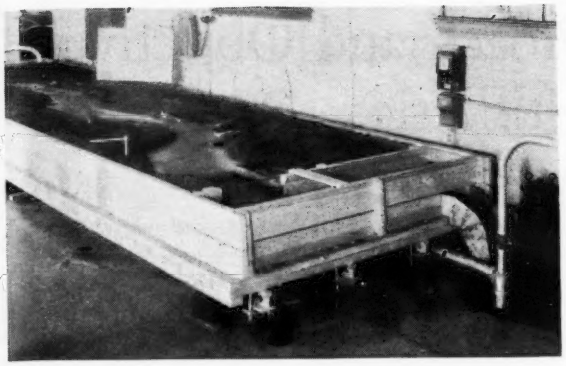
After making these assumptions the following questions presented themselves:

1 What type and shape of deflector should be used?

2 At what angle should it be set?

3 How high should it be placed with reference to flood flow? This brought up the question, At what flow is the stream causing the most damage?


METHOD OF LOCATING JETTIES
Point "A". Location of first jetty, is the intersection of the flow line and the eroding bank. Jetty "C" is located by drawing HB parallel to the flow line and across the toe of jetty "A". AC is twice AB. Jetty "D" is located projecting a line across the toe of jetties "A" and "C". The remaining jetties are located the same as "D". Supplementary jetty "X" located AC distance upstream from "A"



STREAM MODEL USED TO STUDY PRINCIPLES OF CHANNEL BEHAVIOR AND BANK CUTTING, AND FOR DESIGN AND TEST PURPOSES

4 Where is the proper location for these deflectors?

5 How far should they project into the stream?

6 At what point is the dividing line between the use of deflectors and continuous protection?

7 How nearly could the results in the model be transferred to the field?

From the various tests run in the model the following conclusions were reached:

1 Deflectors of the following types were tried: Full-height triangular; full-height rectangular; sloping triangular; wire sausage, and step-back. The full height types were the most effective in removing sand bars, while those of a step-back type were more effective in causing deposition. The wire-sausage type was also effective in causing deposition and scouring out sand bars.

2 Deflectors set at an angle of 45 degrees with the bank, extended down stream, were the most effective in causing deposition and sand bar cutting. Other angles tried were 90 and 60 degrees.

3 Tests were run at one-fourth, one-half, three-fourths, and full bank height. Deflectors set at full-bank height caused more sand bar cutting, while one-fourth height deflectors caused more deposition.

4 A test was also run to ascertain at what flow the greatest bank cutting took place. It was evident that the greatest damage is done at one-half flood stage, as at this period the banks are undercut and later cave in. This is also evident from field observations.

5 By noting the points where the greatest scour occurred in the model (also in the field), the method of locating deflectors shown in the accompanying sketch was arrived at.

6 Tests were run on various projections into the channel —50, 30, 20, and 10 per cent of the channel width. It was found that more sand bar cutting was accomplished for the longer projection; however, more deposition was caused by the shorter projection. A 30-per cent projection is probably most efficient if it does not restrict the channel too much, thereby causing flooding of adjoining lands.

7 A number of tests were run on various degrees of curves, trying to ascertain a limit for the use of deflectors. It is observed that curves over 30 degrees must have continuous protection. It is pointed out that the key point of a curve moves some for various flows. When the curve is too short the deflector set at this point becomes ineffective, often causing more damage than if the deflector were not installed, as the deflector produces excess eddying.

8 In order to check the model with results in the field, a job which had been installed in the field was run through the model. For all practical purposes the results were identical. One deflector was misplaced in both field and model tests.

9 Deflectors have given more pronounced results in the field than in the model, causing a greater amount of deposition.

10 Very little work was done on continuous protection with the exception of one test, in which wire and poles were used. The model showed the best shape to be a 30-degree toe and 45-degree upper part. This has not been tried in the field.

Various types of work that have been installed in the field have gone through the 1937 spring flood. As a whole, they have been effective. Some structural weaknesses have shown up. Deflectors with vertical sides undercut on the toe badly, and it has been necessary to limit the use of this type of structure. We have limited ourselves to two types, the sloping triangular and the rock sausage.

The sloping triangular allows the current to ease over it and does not cause as much disturbance in the stream. However, it will undercut at the toe if it is constructed with a greater pitch than 30 degrees to the horizontal.

The rock-sausage type is flexible and settles when any undercutting takes place. This type is not adaptable to all conditions, since it cannot be used in protecting banks of a great height. It also causes a greater disturbance locally and is not as effective a control as the sloping triangular type.

In some instances it is cheaper and more reasonable to change the channel than to try to protect it in its present location. This is true on small oxbows and hooks. This change can be easily effected by blocking the old channel, excavating a small new channel, and allowing it to scour out. If a heavy bulkhead is placed across the upper end of the old channel and is supplemented by a wire fence backed with brush at the lower end of the old channel, the old channel will silt and fill in flood times.

Mechanical Methods of Water Conservation

(Continued from page 488)

is especially important. In an article by L. C. Tschudy in AGRICULTURAL ENGINEERING for February 1937, entitled "Water Conservation Engineering in the Northern Great Plains", it is reported that 8 ft is the minimum depth recommended in the states of South Dakota, North Dakota, Montana, and Wyoming. The evaporation losses from April to September, as determined by the U. S. Bureau of Plant Industry (Monthly Weather Review, March 1934), show slightly over 30 in in central North Dakota and increase progressively to 55 in in the panhandle of Oklahoma and western Texas. In years of drought, the evaporation losses are even greater. Some seepage losses are to be expected and with the combination of seepage and evaporation, it is apparent that adequate depth is essential to insure sufficient water during periods of drought.

Mechanical methods of water conservation have demonstrated their worth in many areas. However, if these practices are to have a lasting benefit, it is necessary that a proper land-use program be carried out for the pasture and range lands. Such a program must provide for regulated grazing and agronomic practices which will permit the reestablishment of vegetation on areas where it is damaged or destroyed, and on areas having adequate vegetative cover it must be maintained.

The Economist's Approach and Objectives in Land Utilization

By David Weeks

THE LEADERS of thought in the field of land utilization represent many different types of technical and scientific subject matter and a number of different economic and social points of view. It is natural therefore that in the application of well-established principles to present day problems there should arise a considerable amount of difference in opinion. The difference is caused by the multitude of conditions under which land is used, by differences in problems in the states represented, and by the difference in the particular training and experience of the respective specialists contributing to the general fund of knowledge. Although economists have written a great deal in an effort to develop satisfactory explanations for given types of land utilization under different conditions of comparative advantage, the recent activity and interest in land utilization has been directed more than formerly toward the solution of land-use problems.

I will attempt to indicate the kind of problems in which the land economist shares a mutual interest with specialists in other fields, and the kind of contribution the economist is undertaking to make.

There are a number of problems which are purely physical in themselves, but which lead to economic and social problems. Among these may be included a large group resulting directly from the depletion of natural resources. Thus we find an attempt to substitute "sustained yield forestry" for "cut out and get out" methods of timber production; grazing of the range on the basis of its carrying capacity, in place of destructive practices of overgrazing; soil-conserving land uses for soil-depleting uses; farming on good land for farming on poor land; compact settlement for scattered settlement.

Other land-use problems may arise as a result of a deficiency in some one vital necessity, such as a satisfactory source of supplementary feed; from conflicts of interest where two or more major land uses compete severely with each other; or from the heterogeneous pattern of land ownership which is a heritage of past public land policies. In all of these problems the economist's function is usually that of determining differences in economic returns or in social values to be derived from different classes of land or from different alternative land uses.

The development of economic measures of differential productivity of land is complicated, not alone by the multitude of site factors which combine to give resultant physical producing power, but, in addition, by the fact that with management comes the necessity of stating yields in terms of the treatment the crop receives. With management of the forest, new troubles are in store for the maker of yield tables and site indexes. Just as the foresters, after a hundred years of study, abandoned hope of combining site factors into a site index, and adopted the height of the tree as an indicator of all the forces that made it grow, so there must be developed by the economist indicators of economic productivity, depending upon the soil technologist, the forester, the agronomist, and, other specialists, to determine the geographical limits within which these measures may be used.

The significance of the yields of crops cannot be interpreted alone on the basis of physical site factors. The amount of labor and capital together with the quality of management and other economic reasons may limit production in one area and extend it in another. In their competition for land, crops may be eliminated entirely from the soils upon which they could be made to grow most luxuriantly.

The U. S. Forest Service is collaborating with me in an effort to more clearly define the economic tools with which we are working in delineating the boundaries of major use areas. Briefly, we are considering the different alternatives of land use on the basis of the following general criterion.

We consider "that use of each area is most advantageous in comparison with other uses, when, on the basis of judgment or a weighing of each of the factors listed below, it appears to offer the greatest social and private benefits. The factors to be considered are:

1 Gross returns under present and potential management

2 Net incomes to the entrepreneur, to land, and to capital

3 Net incomes to laborers, and the living conditions involved

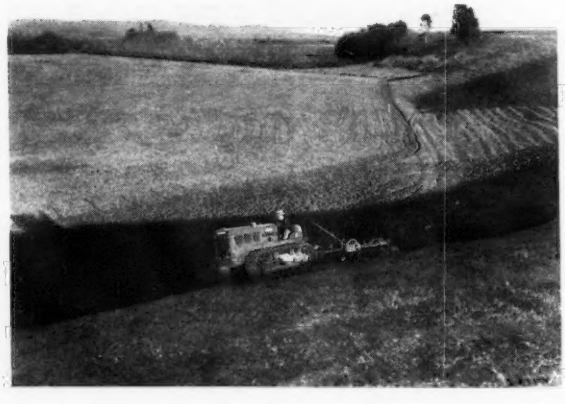
4 Amount of employment and population support provided

5 Stability and social desirability of communities supported

6 The balance of potential tax receipts and necessary public expenditures

7 Intangible social values involved, such as public uses or benefits from conservation of natural resources."

Another important rule might be added to the above where undeveloped land is under *(Continued on page 494)*



Abstract of a paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Berkeley, Calif., February 6, 1937.

Author: Associate agricultural economist, Gianninni Foundation.

The Place of Soil Studies in Land Classification and Land Use

By R. Earl Storie

SOIL STUDIES, in order to be of any tangible value in land-classification or land-use studies, must involve field mapping. Field mapping of soils and soil classification go hand in hand. One may work out an ideal soil classification, but unless it works in the field it is not of much value, except to provide a topic for philosophical discussion. Over a period of about 35 years, the U. S. Bureau of Chemistry and Soils, in cooperation with the various state agricultural experiment stations, has worked out a technique of soil mapping and soil classification that is the basis of our present national soil survey.

When a soil surveyor finishes a survey of the soil in a county, he usually has a great deal of information on topographic differences, geology, native cover crops, and other physical features.

The number of soil examinations made during the course of a field survey depends on the scale of the map and the variability and complexity of the soils. The standard detailed soil survey uses a scale of one inch equals one mile. With this scale one can show areas of about 10 acres. Soil surveyors plan to space their walks at intervals of about ¼ mile. This means that they actually walk across the country at this ¼-mile interval, making examinations of the soil as they go. Two inches to the mile scale appears to be ideal for field mapping in valley lands such as we have in the irrigated West. At the present time we are using this scale for soil surveys being carried on in the San Joaquin Valley. Where necessary we can show an area as small as 5 acres. With the type of detailed soil survey in progress at the present time, a field man can cover between one and two square miles per day. This involves making between 30 to 50 soil examinations. Many holes may be bored to a depth of 6 ft; others may be bored to a depth of 2 or 3 ft, in order to locate hardpan or bedrock. Of course, on some of the alluvial fans at the edge of a valley, we often find it necessary to make three or four times the number of examinations we would make on a level plain where the soil is fairly uniform in character. The detailed soil survey costs between one and two cents per acre.

In view of the increased interest in land conservation, soil conservation and land-use studies, about a year and a half ago a committee on reports, maps and technique of mapping of the American Soil Survey Association sent out a questionnaire intended to ascertain the status and trends of land mapping done by various agencies. Over fifty replies were received. Answers to this questionnaire disclosed some interesting facts. About one-fifth of the answers indicated that they believed the soil survey should be mapped in more detail. A fairly large proportion believed that land use should be mapped. A number mentioned that they believed we should map cover, slope, erosion, and land utilization. Quite a number believed that the soil surveys should include land classification.

Abstract of a paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Berkeley, Calif., February 6, 1937.

Author: Associate soil technologist, University of California. Asso. Mem. ASAE.

There seemed to be a general feeling among the people answering this questionnaire that the soil survey was basic in all of these land conservation and land-use problems and that it could be used with some modification and amplification. The final objective of the soil survey should be to map, classify and find out all that can be determined of the soils of the area.

For years soil survey has been under pressure to increase the rate of progress without any increase in funds. Experiences of the past three years have shown that a complete physical inventory can be accomplished by the evolution of the soil survey without necessarily creating a new survey under some different name.

In addition to mapping soil types, some agencies have been mapping and classifying slopes, erosion, cover, and land use. The U. S. Soil Conservation Service in their erosion surveys have been using a composite symbol on their maps in order to indicate each area designated. For example, the composite symbol 2–*P*/*E*–3, would delineate an area of land, the symbol 2 designating the soil type, the symbol *P* designating that it is pasture land, the symbol *E* indicating the slope group, and the symbol 3 the type of erosion. In addition to showing these soil, land-use, and erosion features, cultural and natural features, such as buildings, fences, roads, drainage, land-ownership boundaries, and civil boundaries are shown on the maps. The Soil Conservation Service usually uses the aerial base maps so that these natural features appear on the base. Aerial base maps have been used to some extent in the standard soil survey work. They prove valuable since they adapt themselves well for use by the newer and less experienced men who may have a little difficulty in mapping natural features. Not only are aerial base maps of value to the soil surveyor, but they play a part in other types of mapping work that may follow. Much needless cost might be eliminated if various agencies carrying on land-use studies could combine in securing good aerial base maps.

Maps 1, 2, and 3 illustrate the procedure followed by the author in the evolution of the soil map (1), through the soil grade map (2), to the natural land type map (3).

The standard soil map (1) sets forth soil differences such as those due to texture, color, depth, alkali content, lime content, stone content, the presence of hardpan, claypan, or other physical and chemical properties. Topography, surface relief, erosion, and drainage factors are also included in this classification.

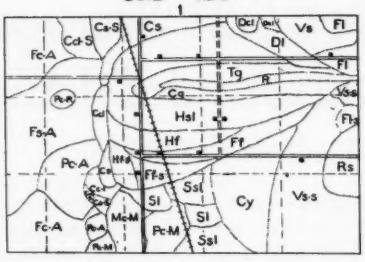
On Map 2 these soil types have been rated on a percentage basis and then divided into 6 grades. Under this grading system, grade 1 soils (rating between 80 to 100 per cent) are potentially the best agricultural soils; while at the other end, grade 6 soils (rating from 0 to 9 per cent) consist of non-agricultural types such as rough stony land or riverwash.

In physical land classification, it is necessary to have more information on land characteristics, problems, and adaptation than is shown by the soil grade. For studies in land or water use it is useful to delineate bodies of land having a uniformity of natural physical characteristics. This has been termed by a number of land utilization people a

natural district or a natural land type. It might be well at this time to define what we consider a natural land type. It has been defined as "a land unit having a particular set of defined natural physical characteristics such as soil, relief, drainage, natural vegetation, and climate." These characteristics define its natural productivity for plants. The natural land type as used in this discussion appears to be a valuable land unit in that it should be the physical unit for study in land utilization work.

With a good soil survey as a basis and the other information that can be collected in the progress of soil survey, it is not difficult to prepare a natural land type map. It appears possible that the soils men can work very profitably with the land economist in the interpretation of soil information in terms of the degree of adaptation of land types for various uses. The recognition of all of our differences in soil color, texture, parent material, etc., we consider sound, but unless a definite grouping of soils based on those significant characteristics that affect crop production and adaptation is indicated by the person making the soil map, it cannot be readily used in evaluating soils from a practical land-use standpoint. It appears that the soils man and land economist could work up this material together, even to the extent of use-district classification about which we have heard so much in land-planning work during the last two years. The report of the Committee on Land Inventories and Land Classification of the National Resources Board under date of November 5, 1932, states as follows: "Since the soil is the dominant factor in local land character, it is evident that the soil maps must be used as the basis for detailed differentiation of land units."

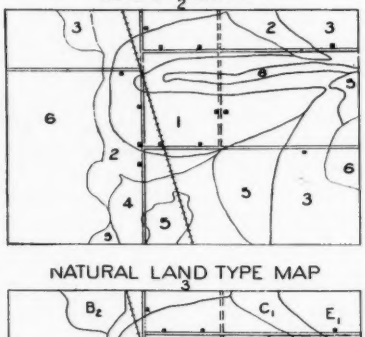
SOIL MAP 1



LEGEND - SOIL MAP

SYMBOL	SOILS	RATING	SYMBOL	SOILS	RATING
Cd	China clay loam	72	Hsl	Hanford sandy loam	95
Cd-S	China clay loam slight alkali	56	Hf	Hanford fine sandy loam	100
Cd-M	China clay loam moderate alkali	23	Hf-s	Hanford fine sandy loam shallow phase	75
Cs	China silty clay loam	77	Mc-M	Merced clay loam	24
Cs-S	China silty clay loam slight alkali	61	Pc M	Pond clay loam moderate alkali	18
Cg	Cajon gravelly sandy loam	52	Pc-A	Pond clay loam strong alkali	3
Cy	Cuyama sandy loam	15	R	Riverwash	2
Dl	Delano loam	76	Rs	Rough stony land	5
Dcl	Delano clay loam	64	Ssl	San Joaquin sandy loam	25
Fl-s	Fallbrook loam steep phase	15	Sl	San Joaquin loam	25
Ff	Foster fine sandy loam	90	Tg	Tujunga gravelly sandy loam	52
Ff-s	Foster fine sandy loam shallow phase	72	Vs	Vista sandy loam	57
Fs	Fresno sandy loam	2	Vs-s	Vista sandy loam steep phase	17
Fc	Fresno clay loam	1	Vss	Vista stony sandy loam	42

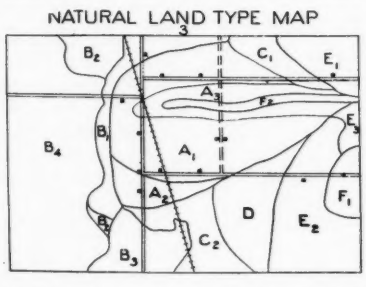
SOIL GRADE MAP 2



LEGEND-SOIL GRADE MAP

GRADE	STORIE INDEX RATING	REMARKS
1	80- 100	Excellent agricultural soils
2	60 - 79	Good agricultural soils
3	40 - 59	Fair agricultural soils
4	20 - 39	Problem soils
5	10 - 19	Topography, alkali or other factors restrict use
6	0 - 9	Nonagricultural

NATURAL LAND TYPE MAP 3



LEGEND-NATURAL LAND TYPE MAP

SYMBOL	TOPOGRAPHY	SOILS	ADAPTABILITY
A_1	Smooth valley	Deep alluvial soils (Hsl) (Hf) (Ff)	Wide range of crops Rate 90-100
A_2	Smooth valley	Alluvial soils resting on hardpan (Hf-s) (Ff-s)	Adapted to most crops Rate 70-80
A_3	Smooth valley	Deep alluvial soils of gravelly texture (Tg) (Cg)	Somewhat limited choice of crops Rate 60-75
B_1	Smooth valley	Deep alluvial soils having moderately heavy subsoil (Cd) (Cs)	Good for field crops, orchard, corn etc. Rate 70-80
B_2	Smooth valley	Same as above but having slight alkali content (Cd-S) (Cs-S)	Fair to good field crop land. Rate 50-80
B_3	Nearly level basin	Brown soils having moderate alkali content (Cl-M) (Cs-M)	Chiefly pasture land Rate 15-25
B_4	Level basin	Heavy alkali soils (Pc-A) (Fc-A) (Fc-s)	Nonagricultural Rate 1-5
C_1	Low smooth terrace	Deep alluvial soils having moderately heavy subsoil (Cd) (Cs)	Good crop land Rate 65-80
C_2	Low terrace "Hog wallow relief"	Red iron hardpan or claypan soils (Ffs) (Ssl) (Sl)	Poor crop land Dry grain Rate 20-30
D	Rolling terrace	Old eroded mesa-dense subsoils (Of)	Pasture, Very poor crop land Rate 10-20
E_1	Gently rolling to rolling upland	Residual soils resting on granite bedrock (Hf-s) (Ff-s)	Fair to good agricultural land, Grains Rate 45-60
E_2	Gently rolling to rolling upland	Stony residual soils (Vss)	Pasture and poor crop land Rate 35-45
E_3	Steep upland	Residual soils resting on granite at various depths (Hf-s) (Ff-s)	Pasture land, Too steep for crops Rate 10-20
F_1	Steep upland	Shallow, stony soils (Rs)	Nonagricultural Low grazing value Rate 3-7
F_2	River channel	Gravel, sand (R)	Nonagricultural Rate 1-3

The Economist's Approach and Objectives in Land Utilization

(Continued from page 492)

consideration for cultivation as follows: After cost of development has been taken into consideration in relation to expected returns, that land which is complementary to existing development uses or benefits from conservation of natural resources."

"Directional measures" is a term devised to take the sting out of the expression "land-use control." Land acquisition by the public as a means of land-use control received a severe blow by the launching of a large number of acquisition projects without a sufficient amount of experimental work, preliminary to the national program. The difficulties included slow-moving government title-approving machinery, time required for investigations of mineral rights, planning of adjustment projects and bargaining for land, incomplete plans, attempt to treat in an emergency program problems requiring a long time for adjustment, difficulty of coordinating governmental agencies, lack of suitable legislation and consequent attempts to proceed under executive orders, local complaints upon the loss of the tax base, lack of understanding by local people of the difficult problems with which they are dealing, deadlines placed upon the availability of funds, forcing the execution of immature plans, disagreement concerning what federal agencies should administer the lands purchased, lack of definiteness concerning the legal scope of authority of the various state and federal administrative agencies, distance of Washington officials from the problems they are trying to solve, and differences of opinion as to how far federal ownership of land should properly proceed.

As a consequence, legitimate needs for funds for rounding out national forests and grazing areas, well recognized as within the proper scope of the government, have been lacking. To further the important work of devising directional measures, a combination of economics and legal specialization is required. While the decisions on which measures shall be applied in any area are the prerogative of the jurisdictions affected, guided by employed planning advisors, the basis for such measures must be laid by research.

Thus the field of land utilization, so far as economics is concerned, divides itself into two important subfields of specialization—economic classification of land and the devising of directional measures. Further specialization, unless it be in the field of public finance and administration, seems unnecessary.

Water Conservation and Supplementary Irrigation in the Northern Great Plains

By M. R. Lewis

THIS DISCUSSION is based on observations made in the two Dakotas during a 3-month assignment with the FERA in the late summer and fall of 1934, a 3-week period in 1936, and the last three and one-half months, supplemented by numerous reports of state and federal agencies, notably the report of the Great Plains Committee, "The Future of the Great Plains". This latter report, in my opinion, gives an excellent picture of past and present conditions in the Great Plains area. It is well worthy of study by any one interested in the problems of that area.

Perhaps the first question pressing for an answer is: "Why the prominence of the drought problem during the last few years?"

Any one or a combination of four reasons—decreased precipitation, denser settlement, changed soil and vegetation conditions, and lower water table—may account for the national interest aroused by the present dry period. These factors are interrelated in many ways and no single one accounts entirely for the seriousness of the present situation. The most important and most obvious factor is the long period of below normal rainfall. However, long-time precipitation records indicate that there have been earlier periods of deficient precipitation nearly if not quite as serious as the current drought. Thus it appears that other factors are involved. Because the population of the area, particularly the number of settlers depending on small-grain farming, increased greatly during the period of relatively high rainfall, the coming of the dry cycle, which began about 1931, affected a much larger number of people, and many of them to a much more serious extent than former droughts.

Moreover, the continued farming of the land to small grain and the overgrazing of the range destroyed the protective covering of native vegetation and so reduced the organic content of the soil that it is much more easily eroded by wind and water.

Largely, and probably almost entirely as a result of decreased precipitation over a period of years, the water table over most sections of the Northern Plains has fallen much below its former level. That the phenomenon is not unprecedented is evidenced by the stories, common in different sections, of lakes that have been dry two or three times since the country was settled, with intermediate periods of plentiful water. It is probable that the water surface of most of these lakes is at approximately the adjacent ground water level.

Oscar Becker, of the staff of the North Dakota State Planning Board, has suggested that the greater use of water by cultivated crops than by the native short grass has reduced the quantity of water percolating through the soil, and thus decreased the natural replenishment of the ground water. Studies at the Nebraska station have shown that in certain areas alfalfa has depleted the subsoil moisture to great depths and that many years are required for this moisture to be replaced. It seems probable that other crops, particularly wheat, may have contributed to the lowering of the water table in this way.

While it is likely that there will again be relatively wet years in the Great Plains area, it is equally probable that dry cycles will return. Conditions that have magnified the ill results of the current drought to the population of the area, as compared with former dry periods, will have similar effects in the future unless radical changes are made in agricultural practices.

Water Conservation. During all but the wettest seasons in the western portion of the area, and over the whole area during periods of normal or slightly subnormal precipitation, water is the limiting factor for agriculture, either farming or stock raising. That this is true has been obvious ever since the earliest exploration, but that there was anything the inhabitants could do about it has been less obvious. For many years a good many stockmen have built small dams to provide water holes on their ranges and a few farmers in especially favored locations have irrigated small acreages. In the extreme western part of what is generally considered the Great Plains area, irrigation has been practiced on a large scale. However, except for the attention paid them in the Black Hills region in South Dakota and the area of the Lower Yellowstone project in Montana and North Dakota, little public consideration was given to water problems in the central and eastern sections of the Northern Great Plains before the emergency drought relief activities of 1934.

Supplementary Irrigation. However, during the past few months there has been a growing realization of the importance of supplementary irrigation. Gradually the idea is spreading that irrigation might play an important part in stabilizing the agriculture, and therefore the whole economy, of the region.

With the increasing interest in irrigation, another danger looms. Our booster friends are flocking to the call in some areas. They want to put whole valleys under irrigation at once with slight attention to costs or the water supplies involved. They plan sugar factories and canning plants, forgetting that the man who is accustomed to farming a thousand acres of wheat land or to riding ten thousand acres of range, is not likely to be willing to crawl on his hands and knees down interminable rows of beets or strawberries. They plan to irrigate hundreds of thousands of acres by pumping from wells because in their section the wells have not gone dry and this farmer or that has been able to irrigate a half-acre garden, forgetting, or rather never thinking, that the ground-water supply may be the gradual accumulation of centuries and might, if their plans were consummated, be dissipated in a few short seasons. They plan to lift water one hundred feet or more to grow garden truck, unmindful of the history of high-lift pumping in sections with much more favorable climatic conditions.

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 24, 1937.

Author: Irrigation engineer, division of irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture, and soils department, Oregon Agricultural Experiment Station. Mem. ASAE.

Most thoughtful observers are agreed that in a large part of the Plains area, including nearly all the area west of the 100th meridian, livestock raising should be the paramount agricultural activity. It is as an adjunct to the livestock industry and to extensive dry-land farming in the limited areas suitable for grain farming, that irrigation promises to be most useful. Supplementary irrigation, in the sense used here, means the use of irrigated crops to supplement the food and feed supplies furnished in the main by nonirrigated areas.

The production of vegetables and small fruits in home gardens is of distinct value in an area devoted to large-scale agriculture. During periods of stress due to drought or poor market conditions, a considerable part of the family living can be grown on a small garden such as may be irrigated with water stored behind a small dam or pumped from an ordinary farm well. Even in times when the income from major farm operations is ample for the purchase of all necessary food supplies, there are distinct advantages in the home garden on the farm. These are particularly evident in an area such as the Great Plains, where it may be many miles from a farm to the nearest town, which in turn may be only meagerly supplied with fresh vegetables and fruits brought in by truck and train from distant market gardens.

However, in my opinion, it is in the production of forage, particularly alfalfa hay, for the winter feeding of livestock and as a reserve for emergency use in dry years such as 1934 and 1936, that irrigation will be of the greatest value. A tremendous quantity of forage is available for livestock during all but the winter months in this area during normal years, and there is a considerable supply in most sections during a part of the dry years. This range forage can be efficiently utilized only if adequate supplies of winter feed are available. If winter feed is available, the range can be utilized; therefore the value of forage is probably greater in the range area than in another area where no summer range is available.

Supplementary irrigation of this kind is practiced in the stock-growing sections of all the far western states. In some sections large irrigation projects are largely devoted to the production of forage or other stock feed which is sold to stockmen. The latter generally bring their stock to the irrigated farms in the fall and feed the produce on the premises. In other sections where land or water is scarce, the stockmen's home ranches are located on small streams where they can produce the essential winter feed.

In the Dakotas the prospects for the larger type of irrigation projects are confined chiefly to the Missouri River bottoms. Even along the Missouri River individual projects will probably be small, ranging from a few hundred to a few thousand acres. The river meanders from side to side of its present valley, flowing along the base of high cliffs, first on one side and then on the other. Because of the difficulty of carrying water along the face of these cliffs, large systems supplied by main canals do not seem feasible. On account of the flat gradient of the river, enormously expensive diversion dams would be required to divert water at levels high enough to avoid the cliffs, and even then the canal lines would be in very broken country. On the whole, the most feasible method of utilizing the water of the Missouri River on the adjoining lands is by pumping it onto individual bottoms or terraces.

Somewhat the same conditions exist on the tributaries flowing into the Missouri River from the west. The summer flow of all the tributaries below the Yellowstone is inadequate for the irrigation of all the land that might be developed. In fact, it is probable that storage of all the nonirrigation season and flood flow would still not suffice during dry years to supply all lands that might use it.

Surveys by the U. S. Bureau of Reclamation and the U. S. Army engineers show that, for the most part, the cost of development of these tributary streams by adequate storage reservoirs and either gravity or pumping irrigation systems cannot be repaid entirely out of direct benefit to the irrigated land or by local flood protection. However, some authorities are of the opinion that the federal government could well afford to build the necessary reservoirs on the headwaters of all these streams because of the general benefits to be derived from the stabilization of both rural and urban life in the area, the decrease in such items as emergency relief and feed loans, increased income to public utilities, and an indeterminable decrease in flood hazards. The development of irrigation in the valleys below the dams might then be carried on by any one of a number of agencies heretofore active in that field, and stored water might be released either at a more or less uniform rate throughout the year or in conformity with local needs.

East of the Missouri River the need for and very often the possibilities of supplemental irrigation are smaller. In the valley of the Souris or Mouse River in North Dakota, flood irrigation of wild hay meadows has been carried on for a long time. In the past the natural flooding of the river bottoms by the spring runoff has been relied upon, but one project has been completed during the past few months for control of the flow and for artificial flooding.

One interesting venture in irrigation is being made in the Minnesota portion of the Red River Valley. A large operator near Moorhead irrigated an 80-acre field of potatoes during the late summer of 1936 with fairly profitable results, and this year (1937) is planning to irrigate 800 acres of sugar beets. The water supply comes from large pits in a gravel beach of ancient Lake Agassiz. The gravels yield water freely, but how large a permanent supply can be developed has not been estimated.

A period of dry years about 1911 encouraged the initiation of a number of irrigation enterprises in South Dakota, but these were hardly under way before a succeeding period of more than normal precipitation led to their abandonment. Whether the irrigation now being started in the region will meet the same fate probably depends on the precipitation of the next few years. If the drought continues for a few years longer, irrigation will become well established in the western portions of the Dakotas, and it is probable that the practice will survive any ordinary period of normal precipitation. On the other hand, if the precipitation is such during this and the next two or three years that even fair crops can be grown without irrigation, it is not at all unlikely that many of the irrigation systems now being planned will be abandoned.

The farmers and stockmen of the region are not accustomed to irrigation and will undoubtedly have plenty of difficulties during their initiation into the new practice. These difficulties will serve to discourage them from continuing their irrigation if natural precipitation will serve even moderately well. If drought continues, they will doubtless overcome the preliminary difficulties and may find that the benefits of irrigation are greater than the costs, even during normally moist years.

Toward Better Farm Buildings

By W. G. Kaiser and G. B. Hanson

THE MORE alert industries in the farm building field have found it greatly to their advantage not only to improve their building products, but also to develop and cooperate with other agencies in the development of better farm building plans and building practices. Also these industries have been active in working with such institutions and agencies as the state agricultural colleges, the U.S. Department of Agriculture, the National Fire Protection Association, and a host of others.

Progress toward better farm buildings generally, has of necessity been slow, but there has been definite progress. Over the past 25 years a creditable volume of better farm building has been completed. A careful review of the record will, however, convince all agricultural engineers that much remains to be done to make present-day farm construction as truly modern as new industrial buildings and urban homes.

There is only one effective way to secure speedier progress in better farm structures. That way is for the building industries, the policy-making groups in governmental agencies and institutions, interested professional groups and others, all to accept their respective responsibilities; then to pursue vigorously a sound and united plan of action to get the farmer and the rural contractor to adopt the more valuable modern building practices.

Industry has accepted its responsibility by developing and proving the worth of a great variety of better building products and by prosecuting comprehensive advertising and educational programs. In order that present-day farm building may enjoy the advantages of these modern inprovements, however, all agricultural engineers concerned with this field must accept their responsibility by bringing their professional recommendations in farm structures up to date and in step with the advance of modern construction practice. Any alternative course is most likely to result in a continuation of the present unhappy situation, where a large proportion of farm structures recommendations show no appreciable improvement over those made ten, twenty, thirty, or even fifty years ago.

In attempting to develop or improve a product for better farm buildings, industry appreciates that certain fundamental requirements must be met. These requirements may be briefly summarized as follows:

1 The completed building must be substantial to provide dependable shelter. Dependable shelter is the primary consideration for any farm building, whether it be for the family, the farm crops, animals or their products, or for the housing of equipment. There can be no compromise with this basic requirement.

2 A moderate first cost and a low annual cost of the farm building are perhaps of next greatest importance. If the first cost is not moderate, no sizeable farm building market will exist. And if the annual upkeep is high, a substantial part of cash income must go for repairs and replacements each year. Cash income being very moderate on the average farm, high upkeep costs encourage continual postponement of repairs, and aggravate the problem of securing attractive and well-maintained farm buildings. In fact, this high upkeep cost, on a large portion of our farm buildings today, is a shortcoming which challenges the building industry and every agricultural engineer to find a more complete remedy.

3 Better farm buildings must also meet the requirement of more efficient production, which properly includes the requirement that they be more comfortable and attractive to live and work in. Most ordinary farm buildings are in urgent need of repairs, alterations or complete replacement to make possible efficient production of the high-quality farm products which are increasingly in demand today. The common lack of comfort, both for the operator and his livestock, found in the average farm structure, is too well known to need further elucidation.

Improvement in Farm Housing. The building industry has contributed much to better farm housing in recent years. During the past few years the cement industry, for example, has developed or improved several products which make the modern low-cost, firesafe, masonry home a reality. With the tremendously greater fire hazards existing on the farm, the firesafe farm home will, no doubt, eventually be considered more necessary than the firesafe home in urban areas.

Many of us have failed to appreciate that fire losses on the farm are much greater, are more complete losses, than is the case with city property. In fact, rural fire losses are greater than city losses by a ratio of 15 to 1, according to a recent statement by the U. S. Department of Agriculture. Knowing too, that rural fire losses are costing hundreds of lives and millions of dollars each year, it should be clear that here indeed is a serious question of firesafe construction which deserves more careful attention and prompt remedial action from agricultural engineers and others interested in better farm structures.

The cement industry has been doing, and continues to do, an effective piece of work in developing better homes of concrete construction and these homes have the advantage, among others, of being firesafe. Efforts to date have been confined mostly to urban homes because of the concentrated market in urban centers, but in variety of architecture and cost of construction, the concrete home is also well adapted to rural conditions anywhere in the United States.

The substantial advance in construction of concrete homes has been accelerated through the development and improvement of cement products and building practices. Some of the more important of these developments which are discussed here are the precast concrete joist floor, the weatherproofing of masonry walls, the study and development of economical, insulated, concrete walls, and finally the development of a simplified and economical type of hollow double-wall construction of concrete.

Precast Concrete Joist Floor. This is one of the major developments by the cement industry, which appears to be outstandingly adapted to farm building construction. The concrete joist is of a modified I-beam shape. The joists have a compression bar in the top flange and a larger tension bar in the bottom flange. The necessary stirrups extending through the top of the joist, furnish shear reinforce-

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Presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 22, 1937. Abridged.

Authors: Respectively, manager, cement products bureau, Portland Cement Association (Mem. ASAE) and agricultural engineer, Portland Cement Association. (Assoc. Mem. ASAE.)

ment and hold the reinforcing bars in position. They also provide additional anchorage in the concrete slab, thus producing T-beam action.

Weatherproofing of Masonry Walls. Another contribution of the cement industry toward better buildings has been the long series of tests made on many types of masonry walls. During the development of walls built of masonry units to produce concrete ashlar patterns, the investigation of weatherability of the walls was initiated to determine just how coarse a texture might be employed. The results to date show that two coats of portland cement paint will provide a durable and effective waterproof surface for concrete masonry walls. This type of waterproofing is now common practice in concrete masonry construction above grade. Waterproofing of walls below grade is accomplished by conventional methods of tile drainage at the footing with one or two cement plaster coats on the outside surface of the masonry wall.

Hollow Double-Wall Construction. The hollow double wall of monolithic concrete construction is not a recent development. Certain favorable conditions which now exist, however, warrant its much wider application in farm construction. One make of patented steel form is now available at such a low cost as to make this method of wall construction of exceptional interest.

The fact that farmers so often do their own building is a feature making this type of hollow double-wall construction particularly fitted to rural conditions. The average farmer finds these forms so easy to use that he can build all ordinary walls without calling on skilled help.

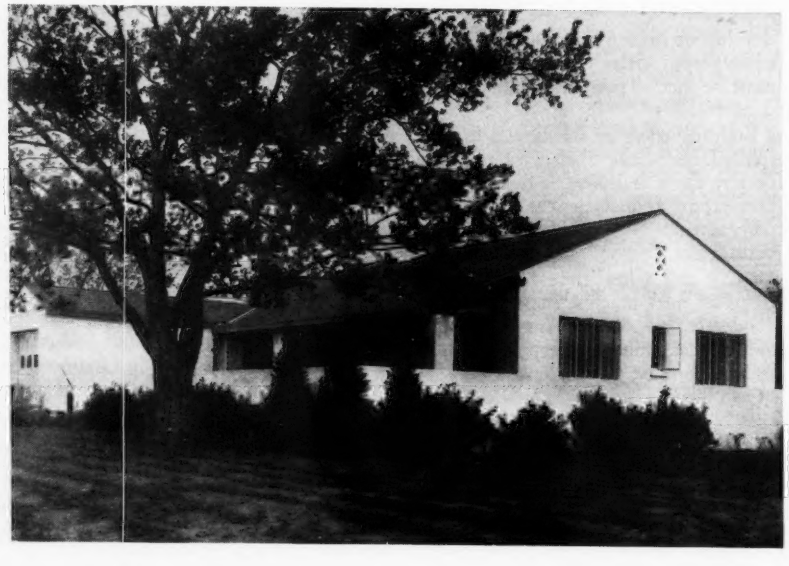
Insulation of Concrete Walls. A comprehensive series of tests of the insulating values of concrete construction was completed last year. These tests were sponsored by the American Society of Heating and Ventilating Engineers in cooperation with the University of Minnesota and the Portland Cement Association. They have determined thermal properties for all common types of concrete construction.

Other Promising Developments. The preceding examples have been selected as typical of the contributions which the cement industry has made in recent years toward improved building products and practices which are eminently suited to the advancement of better farm buildings.

New developments, just looming into view on the horizon of better building practice, seem to offer interesting possibilities for the near future. Although investigation of these new developments in our laboratories has not, as yet, progressed to the point where definite information can be made public, a glimpse of one or two of these which have important applications in farm structures, will be of interest to all forward-looking agricultural engineers.

One possibility now being explored is an insulating plaster for interior surfaces of monolithic concrete and concrete masonry. The use of a portland cement plaster combined with an expanded micaceous ore seems to offer several unique advantages. In the first place, the one operation of plastering will accomplish both an attractive and serviceable plaster coat and at the same time provide low enough thermal conductivity to secure sufficient insulation of the dwelling. The result will thus be an appreciably lower construction cost. Besides performing these two operations at one stroke, the new plaster promises to be tough and elastic in character, thus precluding the possibility of shrinkage cracks common to present-day plasters. Indications are also that it will remain unaffected by moisture changes, which is important where the wall may be exposed to moisture condensation so destructive to plasters now commonly used. Finally the new plaster, because of its inherent porous nature, furnishes a desirable factor of high sound absorption not found in common plasters.

Another subject of investigation in our laboratories at present, which may produce even greater benefits in future farm structures, is that of soil-cement mixtures. Definite information on this subject cannot as yet be published, but stabilization of common soils with portland cement seems to offer such startling possibilities in farm structures as to warrant our most careful and thorough examination. Soil-cement mixtures for road surfacing seem to show enough promise to warrant the question as to whether this practice may not also provide an economical source of farm pavements, paved feeding lots, floors for certain farm buildings, more stable and durable structures of rammed earth, etc. The proper combinations of small amounts of cement with soils of many different kinds, which contain certain percentages of moisture, obtain such favorable characteristics of hardness and durability as to suggest that here indeed may be a development which will bring important changes in farm construction at some future time.



Recent Progress in Forage Drying

By W. M. Hurst

THERE seems to be no record of the first attempt to dry forage crops artificially in this country. We do know, however, that about 1910 a drier was set up in Louisiana for drying native grasses. Since that time commercial, state and federal agencies have done much work in attempting to develop suitable drying equipment for general farm use. While this objective has not been reached, nevertheless a considerable quantity of forage is now dried artificially.

Since the hay driers now in use are too expensive, except for feed-processing plants or large farms, the problem is to design economical small units. At present a great deal of the value of our hay crops is being lost by reason of improper curing, and more and more farmers are recognizing this fact. The demand from the smaller farmers for a solution to the problem is already evident, and is likely to grow.

The ASAE Committee on Crop Drying recently made a survey, through a questionnaire sent to all known owners or operators of forage-drying plants in the United States. The results of this study, which was made by Mr. Lamar M. Kishlar[1], form the basis for this report.

Questionnaires were sent to 57 owners or operators of forage driers and replies were received from 44 of them, who reported 62 driers in operation in 1936. Of these driers Arkansas has 4, California 7, Florida 2, Indiana 1, Illinois 1, Kansas 4, Louisiana 5, Michigan 2, Minnesota 2, Montana 1, Missouri 1, Nebraska 4, New Jersey 4, New York 3, Ohio 6, Oklahoma 2, Pennsylvania 9, Tennessee 1, Vermont 1, Washington 1, and Wisconsin 1.

The reports show these machines turned out more than 89,000 tons of dried material in 1936. Crops dried included alfalfa, bagasse, corn, clovers, lespedeza, oats, pasture grasses, peas, soybeans, seaweed, sudan grass, timothy, vetch, and wheat. About 75.0 per cent of the tonnage handled was alfalfa; bagasse made up 18.0 per cent; and the several other crops, 7.0 per cent. Six of the driers reported are operated by state and federal agencies in connection with research work. The New Jersey, Vermont, Pennsylvania and Florida Agricultural Experiment Stations each reported one machine and the U. S. Department of Agriculture reported two. With one exception these are factory-made installations. The exception is an experimental unit constructed by the Bureau of Agricultural Engineering which is being used to dry a small acreage of crops on the Iberia Livestock Farm at Jeanerette, Louisiana, primarily for dairy cattle feeding experiments.

Hay driers are at present used commercially only by feed processors and large farming organizations. Approximately 88 per cent of the 1936 production was reported sold, most of it alfalfa in the form of meal. While only a few producers have adopted artificial drying, more and more of them are recognizing its possibilities. Estimating on the basis of the ASAE survey, there were in 1936 possibly 80 plants operating in this country with a combined production of about 100,000 tons. Forage driers can now be purchased from at least six manufacturers.

In this country driers have been designed for large-scale operation, with high capacity and minimum labor requirements. In England the development has been more toward small, low-cost machines for general farm use. The kinds of crops dried and general farming practices have also had considerable influence in this connection. In the United States alfalfa is the principal crop dried artificially, whereas in England they dry mostly grass. In order to obtain feed with the highest possible nutritive value, the grass is cut at a very immature stage, with only a few weeks between cuttings. The yield per acre for each cutting is, of course, quite low. Thus a drier which will produce a few tons of dried hay per day can be kept in continuous operation during the haying season. The February 1937 issue of the English journal "Rural Electrification and Electro Farming" reports about 46 driers in England in 1936 with combined annual production of approximately 10,000 tons.

Artificial drying of forage has been stimulated greatly in recent years by the findings of research workers in allied fields. Feeding trials in this and other countries have shown conclusively that artificially dried hay is usually of higher feeding value than field-cured forage, even of the same class and grade. There is no loss of mineral elements in artificial drying, and the carotene content, the source of vitamin A activity, is higher than in field-cured hay. According to tests made by the U. S. Bureau of Dairy Industry, the production of milk and butterfat of dairy animals fed only artificially dried alfalfa hay, salt, and water may be as much as 70 per cent of normal production made on a ration including a good grain mixture and silage. With artificially dried alfalfa hay it is possible to reduce the quantity of expensive concentrates in a ration.

Types of Driers. Three general types of driers were reported in the ASAE survey—the rotary, apron, and draper types. The rotary drum driers may have one, two or three drums. The apron conveyor machines are similar to those commonly used for industrial purposes, but designed to facilitate the handling of hay. The draper type is similar to driers used for tobacco, the hay being held in festoons while passing through the drying chamber. Approximately 79.1 per cent of the driers reported are of the revolving drum type, 14.5 per cent of the apron conveyor, 4.8 per cent of the draper type, and 1.6 per cent combination rotary and conveyor. Drum driers handled 66.3 per cent, apron conveyor 23.7 per cent, draper 4.5 per cent, and combination rotary and conveyor 5.5 per cent of the 1936 tonnage.

In apron conveyor and draper driers it is customary, with some exceptions, to dry the plants unchopped. In drum driers the forage is chopped, and sometimes shredded, before it is fed to the machine. For most efficient operation of drum driers, forage plants should be reduced to as fine and as uniform size particles as practicable.

Few operators (20 per cent) reported partial field drying in 1936. The most common practice was to bring the material to the drier immediately after it was cut. Partial

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Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 24, 1937.

Author: Associate agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Assoc. Mem. ASAE.

[1]Manager of research, Ralston Purina Company. Mem. ASAE.

TABLE 1. REPORTED DISTRIBUTION, TYPE, AND 1936 OUTPUT OF FORAGE DRIERS IN THE UNITED STATES

OPERATORS		DRIERS						FORAGE DRIED				
					Drying air temperature							
Report number	State	Type	Units, number	Rate capacity, tons per hr	Feed, deg F	Discharge, deg F	Fuel used	1936 production, tons	Kind	Period of exposure	Immediately after cutting	Partially field dried
34	Ark.	Rotary	1	(Under construction)								
40	Ark.	Rotary	2	0.75	1500	250-300	Oil		Alfalfa and other crops	6 to 10 min	Yes	
41	Ark.	Rotary	1	1.0	300	120	Oil	750	Alfalfa	20 sec	Yes	
1	Cal.	Rotary	3	3.5	950	300	Oil	8,300	Alfalfa	8 min	Yes	
13	Cal.	Rotary	3	0.2 to 0.5	1800-2800	330	Gas	2,500	Kelp	30-7 min		
27	Cal.	Combination rotary and conveyor	1	2.0	900	250	Gas	4,953	Alfalfa	Rotary 5 min Conveyor 25 min	Yes Yes	
32	Fla.	Rotary	1	2.0	1650-1800	275	Oil					
36	Fla.	Rotary	1	0.5	1200-2000	185	Oil		Napier grass, crotalaria, cowpeas	Few seconds	Yes	
14	Ind.	Rotary	1	1.5	1200	256	Oil		Alfalfa		Yes	
35	Ill.	Rotary	1	1.0	(Under construction)		Oil			4-6 min	Yes	
20	Kans.	Rotary	1	1.5	1400	275	Gas	2,000	Alfalfa	5 min	Yes	
21	Kans.	Rotary	1	1.5	1400	275	Gas	2,000	Alfalfa	5 min	Yes	
22	Kans.	Rotary	2	1.5	1400	275	Gas	2,000	Alfalfa	5 min	Yes	
25	La.	Rotary	1	3.0	1800	220	Oil	(16,440)	Corn and oats, bagasse	5-6 min	Yes	
26	La.	Rotary	3	4.0	1800	220	Gas			5-6 min	Yes	
38	La.	Rotary	1	0.5	800-1000	250	Oil	69	Clover, soybeans, and pasture grass	2-3 min	Usually	2-24 hrs
2	Mich.	Conveyor	1	1.75	275	115	Oil	1,400	Alfalfa	17-70 min	Usually	4-5 hrs
29	Mich.	Rotary	1	1.5	1000	250	Oil	1,195	Alfalfa	10 sec, 10 min	Usually	15 min-2 hr
43	Minn.	Rotary	2	1.0			Gas	800	Alfalfa	10 sec, 1½ min		Yes
19	Mont.	Conveyor	1	1.5	275	210	Gas	600	Alfalfa	30 min	Yes	
16	Mo.	Rotary	1	1.0	1300	125	Oil	2,036	Alfalfa	1 min	Yes	
12	Neb.	Rotary	1	0.6	400	250	Oil	125	Alfalfa	4 min	Yes	
28	Neb.	Rotary	2	1.5	1200-1500	225	Gas	1,910	Alfalfa	3-5 min	Yes	
30	Neb.	Rotary	1	1.5	1000	250	Gas		Alfalfa	10 sec, 10 min	Usually	15 min-2 hr
8	N. J.	Rotary	2	1.0	1200	350	Oil	1,500	Alfalfa 90 per cent, wheat and vetch, 10 per cent	2 min	Yes	
9	N. J.	Rotary	1	1.0	2000	325	Oil	600	Alfalfa 80 per cent, soybeans 20 per cent	2-5 min	Usually	4-5 hr
18	N. J.	Rotary	1	2.0	1100	250	Oil	250	Mixed grasses, clover and rye	3 min	Yes	
10	N. Y.	Conveyor	2	1.75	250	125	Oil	2,000	Alfalfa 99 per cent	30 min	Yes	
15	N. Y.	Rotary	1	1.25			Oil	1,000	Clover, timothy		Yes	
4	Ohio	Rotary	2	3.0	1800	250	Oil	2,500	Alfalfa	2 min	Yes	
17	Ohio	Rotary	2	5.0	2000	215	Coal	3,826	Alfalfa		Yes	
39	Ohio	Rotary	2				Oil	6,000	Alfalfa	3 min	Yes	
3	Okla.	Rotary	1	1.0	800-1200	175-200	Gas	600	Alfalfa	3-5 min	Yes	
23	Okla.	Rotary	1	1.5	1400	275	Gas	2,000	Alfalfa	5 min	Yes	
5	Pa.	Draper	3	3.5	250-275	150	Oil	4,000	Alfalfa	28-45 min	Yes	
6	Pa.	Conveyor	2	6.0	250	120	Coal	8,000	Alfalfa	25 min	Yes	
7	Pa.	Conveyor	1	1.5	250	135	Coal	1,000	Rye, oats, peas, soybeans and corn	40 min	Yes	
31	Pa.	Conveyor	1	3.0	150-250	100-110	Coal	4,000	Soybeans, reconditioning cotton	25 min	Yes	
33	Pa.	Conveyor	1	4.0	200-250	100	Coal	4,000	Alfalfa	25-45 min	If possible	Within 12 hr
42	Pa.	Rotary	1	1.0	1000-1450	235	Oil	9	Alfalfa	1-6 min	Occasionally	5 to 7 hr
37	Tenn.	Rotary	1	1.0	1000	200-300	Oil	147	Lespedeza, Sudan grass, soybeans	2-3 min		Sometimes
24	Vt.	Rotary	1	1.0	1000	180	Oil	12	Timothy, rye and soybeans	¾-2 min	Usually	1 hr
44	Wash.	Rotary	1	2.0	1200	280	Oil	100	Clover, timothy	1-6 min	Yes	
11	Wis.	Rotary	1	3.0	700-1300	230	Oil	400	Alfalfa	2 min		2 to 5 hr

NOTE: Information in this table was collected by Lamar M. Kishlar. Acknowledgment is also made of the assistance of J. H. Fulmer, C. W. Boag, and G. D. Arnold.

field drying is associated with some loss of carotene but with a material reduction in cost of drying. There seems to be insufficient information available for a definite recommendation on this point.

Fuels and Drying Temperatures. Practically all forage driers utilize the products of combustion from a furnace for drying. Some excess air is drawn through the furnace and provision is made for admitting additional outside air either to a mixing chamber at the end of the furnace or at the inlet to the drier. It is by this means that the temperature of the furnace gases is regulated.

The term "drying air temperature" refers to the temperature of the mixture of air and combustion gases.

Oil, gas, and coal are the fuels commonly used in the driers. Oil was used in 57.4 per cent, gas in 24.6 per cent, natural gas in 6.5 per cent, and coal in 11.5 per cent of the installations reported in 1936. Most users preferred oil or gas because of the ease of control and absence of smoke and soot. Coal-burning furnaces for hay driers will probably increase in popularity with the use of mechanical stokers. With such developments the initial cost of the fuel will doubtless be the controlling factor.

Drum driers are high-temperature machines in which the forage remains for a short time, 10 sec to 10 min. The low percentage of oxygen in the drying air and the chopping and shredding of the material before it is fed to the machine facilitate quick drying at high temperature without burning. In drum driers the green material is subjected to a temperature of from 400 to 2800 F at the inlet. The temperature of the drying air drops rapidly and is usually about 250 F at the point of discharge, ranging from 120 to 350 F.

In apron conveyor and draper driers the inlet temperature of the drying air may vary from 150 to 275F, depending somewhat upon the make of machine, material to be dried, and its moisture content. The exhaust-gas temperatures are reported at from 100 to 250 F.

Field Curing. Unless very rapid progress is made in the development of driers or some important discovery made in this connection, the bulk of our hay crops will continue to be dried in the field. While research activities in field curing may not return as spectacular or fascinating findings as in artificial drying, possibly greater immediate benefits will result to the average farmer. Jones and Palmer at the Mississippi Agricultural Experiment Station have pointed out ways and means of hastening field drying which have produced higher quality of forage. Their work, as well as that of several other agricultural engineers, on the field crushing of forage plants for hastening field drying, offers practical means of increasing the quality of livestock feed.

We do not know to what extent recent findings in field curing have been put into practice. But we do know that the production of livestock and livestock products per pound of feed consumed has increased materially during the past 10 to 20 years. The engineer can assist in bringing about further increases by providing ways and means of obtaining a higher quality feed at lower cost.

Mechanized Agriculture and Civilization

AN ARTICLE under the above heading, by Harold E. Pinches, head of the department of agricultural engineering at Connecticut State College, appears in the autumn number of "Social Science".

In introducing his subject Mr. Pinches presents numerous facts and figures quite familiar to agricultural engineers, relative to the extent, social influence, and possibilities of mechanized agriculture. For the information of urban readers in unrelated fields of work he reviews the nature of agriculture, the temporary and superficial factors tending to hide the true character of agricultural progress, and an outline of the history of mechanical development of farm tools, together with their related social influence.

From this mooring of fact, the author launches several interesting philosophical implications as to the probable future of agricultural engineering progress and its social implications.

He admits the difficulties of adjustment to mechanical progress, the resulting "technological unemployment . . ., labor displacement . . . ; economic unbalance, social unrest, political upheaval," and indicates that "the benefits to be obtained from the changes must be set against the costs." This can be interpreted as implying that the benefits will more than outweigh the costs.

Arguing at variance with the common theory that "rural population should be maintained at as high a ratio as possible to the urban population," he points out that "in the beginning there was agriculture and no civilization. Man originally had to work so hard as to inhibit the processes of civilization." In going on to show that civilization is a product of leisure and security rather than of subsistence farming, he says of the high civilizations of the few which have sprung up at various times and places, "the degree of civilization attained is similar, whether those few are supported by the slavery of old times, by serfdom, by the tithes of the church, by the unequal trading of colonial commerce, or by the poverty of body and mind of the masses under modern capitalism."

Of two possible ways to leisure and security, he dismisses renunciation of wants as not applicable by the masses, and says "the other way to leisure and security lies in the progressive economizing of human energy by substitution of mechanical energy."

With due recognition of the increase in wealth already created by technological progress, the factors that have obscured this increase from the ordinary observer, and influences which have minimized its use in support of leisure and security, he sums up his viewpoint on the future as follows:

"This unsettled time is one of those periods significant in the development of civilization. We are engaged in another of those surges of invention, of technological change, by which men are further released from the limitations of human physical strength. Agriculture has always been, and still is, the activity which used the largest portion of human energy. There now appears the promise of considerably reducing this human energy demand by the increasing substitution of mechanical energy, by further extensions of technological controls. With these changes will come important consequences and grave problems. But the energy saved should be sufficient for the solution of the problems, and when the necessary social and economic adjustments have been made, there will be found remaining a considerable advance in civilization."

Thus is agricultural engineering linked with the economic and social progress of agriculture, and with the progress of civilization as a whole. Reprints of the paper are available to ASAE members on request to Society headquarters.

NOTE: Information in this table was collected by Lamar M. Kishlar. Acknowledgment is also made of the assistance of

Electricity in Fruit Farm Operation

By W. C. Reed

IN 1912, with the cooperation of six neighbors, we built a rural electric line extending five miles into the country and purchased the current used from the local utility. For a few years we were metered at the point of the city connection and charged with all the loss on the extension. Later the company read the meters at each customer's place and charged only for the energy used.

Until 1919 we used electricity only for lighting purposes in the residence and nursery storage and packing house. About this time the gasoline engine on our water pump wore out and was replaced with an old electric motor of rather antique design. This was our first use of electric power. A few years previously we had started planting apple orchards, and as the orchards came into production we would add an occasional piece of equipment such as a sorter and would power it with an electric motor. About this time the local utility was absorbed by a large central operating company and the service was improved so that it was dependable.

Today we operate 350 acres of land, of which 265 acres are in apple orchards, 212 acres in bearing. As production increased, our needs for power increased in about the same ratio. Spraying was done by portable rigs drawn by teams or tractors and powered with one-cylinder engines that were always too weak for the job, and as a consequence were giving a lot of trouble. In 1928 we were faced with replacement of several old, worn-out sprayers and adding a couple more, with the attendant necessity of more teams or tractors, so we piped 75 acres for stationary spraying and installed one pump of 35-gpm capacity belt driven from a tractor.

Stationary spray plants at this time were coming into general use in the concentrated districts of the Northwest and a few had been installed in the East. Reliable data as to construction details, pipe sizes, operation and management were very meager, but no serious mistake was made and its operation was entirely satisfactory.

Our production at this time had increased to the point that our yearly cold storage expense was a considerable item, and after the fruit left our premises, it was difficult to contact each prospective buyer and show the product. Truck sales were displacing car lot movement and each trucker is of the disposition to bargain, so the need was felt for a cold storage at the orchard. With this in view, we paid for the extension of three-phase electric current from the city limits, a distance of two miles. (The cost was refunded to us four years later).

With electric power available we increased the spray plant to cover 212 acres and installed a double triplex pump run by a 25-hp motor. These pumps were used two years, then replaced with two 50 and one 20-gpm pumps capable of operating at 750 lb pressure. All pumps are independently connected, with separate motors of 25, 20 and 10 hp. This combination was installed to give us flexibility of capacity and a reserve in case of breakage or trouble with any pump. The plant is capable of maintaining sixteen spraymen in the orchard, but twelve is the most we have used at any time. Since the installation of these pumps we have never had an interruption of the spraying in the orchard, except for stoppage of electric current, which has been infrequent. An independent motor runs the agitators in the two 1,000-gal mixing tanks.

All of the bearing portion of the orchard is piped with a pipe line at every fifth row, with a hydrant every 80 ft, from which a sprayman with 125 ft of hose will spray a pattern of 10 trees. Prof. C. L. Burkholder of Purdue University has made a study of costs of stationary plants as compared to portable sprayers and finds a difference of 21 cents per 100 gal in favor of the stationary plant. In our case we use annually 800,000 to 900,000 gal of spray material, and at that rate the plant was more than paid for in less than five years time. It is now seven years old, and we have spent practically nothing for repairs, other than new hose which lasts about three years, and the change of pumps mentioned previously. The average cost per bushel for spraying, the last six years, is 14.2 cents, which includes cost of materials, interest, depreciation, electricity cost, and man-hours labor. The plant is now entirely charged off, and this cost will average downward for the life of the pipe lines, which show no deterioration whatever on the inside and only slight pitting on the outside.

An increasing supply of water was needed as our spraying requirements demanded 30,000 to 35,000 gal per day. Three deep wells are pumped by motors and with storage tanks of 27,000-gal capacity, an ample supply is available.

In 1929 a common air storage of 18,000-bu capacity was built, but its operation was unsatisfactory, due to the high temperatures prevailing during the early storage season, with the consequence that fruit ripened rapidly and the attendant loss from decay more than offset any savings made. In 1931 this building was insulated with sheet cork and mechanically refrigerated by a direct-expansion ammonia system with a 5x5-in compressor powered by a 20-hp motor. The area of refrigerating coils in this storage was enough to give us the desired temperature, but was not enough to give the high degree of humidity desired, so during the peak load season two circulating fans are used, blowing the air through a fine mist spray. Humidity is maintained at around 90 per cent.

In 1935 an additional storage of 25,000-bu capacity was added, refrigerated with two integral cooling units which include refrigeration coils, brine spray, and blowers. The compressor is 5x5 in, driven by a 25-hp motor. An additional 4x4-in compressor was installed to help out on the peak load while the storages are being filled. The compressors are interconnected and can be used on either house, or both, simultaneously.

Costs of operation as determined by ourselves and Prof. C. E. Baker of Purdue University are as follows:

	Unit No. 1 (old)	Unit No. 2 (new)
Cost of building, insulation, and refrigerating machinery	$14,000.00	$13,000.00
Cost per bushel of maximum storage space	0.78	0.52
Fixed charges per year—		
Interest (6 per cent)	$ 840.00	$ 780.00
Depreciation and repairs (6 per cent)	840.00	780.00
Taxes	101.25	101.25

(Continued on page 526)

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 24, 1937.

Author: W. C. Reed & Son; Reed Orchard, (Indiana).

Responsibilities for Adequate Farm Wiring

By George W. Kable

THERE are few persons interested in rural electrification who have not sensed a need for some means of insuring good, adequate farm wiring. Engineers design and build good distribution lines. Manufacturers, dealers, and purchasers are all critical judges of electrical appliances. But wiring, the determiner of use and the essential link between line and appliance, is everybody's interest and no one's responsibility.

Farmers want good wiring. Unfortunately, wiring must be installed at a time when the farm family knows little about the use of electricity and the part wiring will play in it. Entrances, amperes, outlets, wire sizes, and grounds constitute a foreign language not learned from an hour's lecture. The farmer's conception of "good and adequate" wiring is influenced by the immediate use he expects to make of electricity, his available cash, and possibly some wiring job he has seen or heard about on another farm.

Power associations, utilities, and lending agencies need good farm wiring. Operating costs, retirement of loans, and future rate reductions are dependent upon the ability of consumers to use increasing amounts of electricity. For them adequate wiring should provide wire sizes, numbers and location of outlets, and good workmanship which will permit reasonable future expansion of use, safety to life and property, and freedom from service calls. Eventually this will also be the user's criterion for good wiring.

In limited areas and under sponsorship of a few utilities or other interested groups, some good work has been done on farm wiring. It can be done. In territories where service is just being established, where there is no background of experience, and where the lower income groups are having their first fling at electricity, guidance is most needed and is least available.

Concern over farm wiring should not be limited to farmers, utilities, power associations, and lending agencies. The equipment manufacturer, jobber, and dealer must have wires and outlets on farms to sell equipment. The contractor should realize that any steps which will permit the farmer to have better wiring, even at more reasonable cost, will increase business.

Underwriters are faced with the fact that the electrical code is probably complied with less on farms than by any other class of users. Mutual insurance companies are seeking a workable procedure as the number of members having electric service increases. State rural electrification committees, farm bureaus, and other farmer organizations are actively promoting rural service, and must eventually face the problem of securing good wiring or dealing with bad wiring.

Agricultural engineers are associated or have mutual relations with many of the organizations mentioned. They can influence the trend of farm wiring. If we wish to do something about it, we must face the facts.

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, June 22, 1937.

Author: Chief, agricultural engineering section, agricultural industries division, Tennessee Valley Authority. (Now editor, "Electricity on the Farm.") Mem. ASAE.

The job of farm wiring is not a small one. One million farms now have electric service. Half of them may be reasonably well wired. The other half will some day be rewired or additions will be made.

On April 16 the Rural Electrification Administration had executed loans, or lines were under construction to serve 136,000 new customers, and allotments were approved for serving an additional 192,000. This does not include the extensive line-building program of utilities financing their own construction. Present prospects indicate that at least another million farms will be wired within the next five years.

Each new increment of farm users of electricity will represent a group which it has not been feasible to serve previously. Some of these will be prosperous farms of large size where the customer density is four per mile or less. They will use more electricity and need better than average wiring. A majority of the new users will likely have incomes in the lower brackets, where cash for wiring and equipment is limited and every dollar must be made to do its utmost. In the South, and in other limited areas, service will come to many homes having neither paint nor plaster. It will be appreciated as much as in the mansion, and do more to help the country. The wiring should fit the circumstances.

Ninety-five per cent or more of the farm buildings to be wired will be buildings which have been previously constructed. Fishing wires into old houses is quite a different job from attaching wires and boxes to open studding of new dwellings. Present wiring materials and systems are designed primarily for new work.

Manufacturers have provided a variety of new materials in the past few years. New entrance cables, weatherproof meters, and simplified entrances have provided a forward step in design. The cost of range services has been cut in half. Concentric, bare neutral cable is available from a number of sources. A concentric latex and paper insulated, fabric-covered cable is on the market. One of the latest developments is a non-metallic sheath cable with semi-insulated neutral. All of these new cable assemblies are small in cross section, some of them being no larger than a pencil. They are easier to fish into place than the larger cables, would be inconspicuous if placed on wall surfaces as open wiring, and easy to protect from mechanical injury along the frames of doors and windows and over baseboards.

Porcelain manufacturers have developed a line of outlet boxes and covers to be used with knob-and-tube installations or non-metallic cables for completely insulated wiring. Some of these new materials have been used in trial installations, but the possibilities for combining them into wiring systems to fulfill specific farm needs have scarcely been sounded.

It should be recognized that farms in different sections of the country, or tenant and owner buildings on the same farm, may have widely differing requirements for wiring. Practically all printed recommendations for farm wiring aim toward the ideal. The man of small means frequently cannot have ideal wiring. What he needs is specific information on how to get the most for the $20 to $50 he has to invest. There are plenty of places where

a pull chain socket with a long cord to the doorway may be better wiring than a ceiling outlet and wall switch.

With the present increase in the number of farms to be wired, it is becoming increasingly difficult in some sections to obtain a satisfactory job. Contractors who solicit farm wiring are often inexperienced and not dependable, and prices quoted are too low to provide either adequate materials or good workmanship. Reliable contractors frequently will not bid on farm wiring. It takes time to help the farmer plan his system, distances are greater for workmen to travel, old buildings are not always easy to wire, and the kind of competition existing is not conducive to the maintenance of high standards.

H. W. Smoots of the Ohio Farm Bureau rural electrification cooperative stated recently that the farm bureau had found difficulty in securing contractors who were willing to bid on farm jobs. Under present arrangements a Columbus contractor handles all wiring jobs for the state farm bureau. He does the wiring at a specified price per outlet and employs local workmen where possible to make the installations. By giving all the work to one contractor the price has been reasonable, and Mr. Smoots reports that local wiremen are better pleased to work for someone else than to take the responsibility and risk upon themselves.

Several months ago a home demonstration agent in north Alabama selected a farm where demonstration wiring installations might be made. The farm was owner operated. The house contained five rooms, and in addition a barn, poultry house, and brooder house were to be wired. The price which the owner had set for the job was $35.00. After talking with the local contractor, and making careful estimates on the outlets desired by the farm family, it was found the cost would be something in excess of $105.00. Further conference with owner and contractor finally resulted in making the complete installation as recommended for a price of $75.00. This included a 60-ampere entrance, no-fuse load center, and a yard light. The family was greatly pleased over having decided to install the additional wiring, and gave evidence of that pleasure by purchasing an electric washing machine from the contractor. This result was obtained through the cooperation of the home demonstration agent, rural electrification specialist, a contractor, and representatives of the local power distributor.

The licensing of wiremen and the setting up of state codes and inspection bureaus may be helpful in enforcing rules and improving safety conditions. It is hardly to be expected, however, that farmers can be legislated or coerced into adequate wiring—that type of wiring which will give them the greatest satisfaction from their electric service. Too rigid requirements which add materially to the cost may also result in less adequate wiring in the beginning, with unsafe extensions made by the farmer himself after the original job is inspected and approved. These extensions and the use of twisted cords may be more hazardous than a cheaper job installed by a contractor.

Several years ago a very complete and well-designed wiring system was installed on a large demonstration farm. The job was inspected by the Underwriters' representative and a certificate issued. Later I visited the farm and was taken by the farmer to a new poultry house in which he proudly exhibited the wiring which had been done by himself and his son. It was a knob-and-tube job without the knobs and tubes. The conductors were fastened directly to the wooden walls and ceiling with double-pointed tacks, and in some cases were no more than an inch apart. There are other instances of the kind, and they cause one to wonder whether it is not more important to provide education than regulation. Perhaps what we need most is a foolproof wiring system with foolproof materials.

Where effective work has been done in improving farm wiring, it has resulted almost invariably from education. The education is of two types. First, the farmer and his wife must know something about their possible immediate and future use for electricity. They should know of the different types of outlets, sizes of wires, and capacities of entrance services. They need help in planning their layout and should be informed regarding what constitutes a good wiring job and what it will cost.

Another and quite distinct problem is that of working with contractors in the selection and use of materials and wiring systems which are consistent with the type of buildings to be wired and which will give the farmer the most for his money. This may mean choosing between concealed and surface wiring, conduit or non-metallic sheathed cable, or between additional outlets and larger wire sizes.

Farm wiring is primarily a farm problem. The agricultural engineer should endeavor to look upon it from the farmer's point of view and speak for him in enlisting the aid of others for a satisfactory engineering and economic solution. Manufacturers, jobbers, dealers, contractors, utilities, and power associations will all share in the results obtained. They have a responsibility to aid and must recognize that the problem will only be solved when the solution is satisfactory to the farmer who pays the bill.

In carrying the educational work to the farm, the home demonstration agent, county agent and Smith-Hughes teacher are in the most advantageous position. They are busy persons, busy working on farm problems. And farmers are interested in electricity.

BARNS AND OUTBUILDINGS NEED GOOD WIRING TO INSURE SAFETY OF INVESTMENT, SAFE WORKING CONDITIONS, EFFICIENT OPERATING PRACTICES, AND USE OF A PROFITABLE AMOUNT OF CURRENT

A Special Problem in Soil Conservation

By William X. Hull

EVERY problem in conservation is a special problem, for we cannot attack conservation with standardized plans and specifications, as can the motor car manufacturer with his mass production methods.

There is a small tribe of our fellow members, unheralded and unsung, whose story needs telling. They are too modest to tell it themselves, so I am going to try to describe the activities, troubles and problems of this engineer; a new type of engineer, perhaps, but an agricultural engineer. I shall use, as a subtitle to the one assigned, "The Cow Range Engineer, His Problems and Tribulations." To picture this "cow hand's" troubles, let us take an Arizona ranch and go right through the story of his methods of erosion control.

This ranch, which as to terrain, erosion, vegetation, and climate, is more or less typical of most southwestern ranches, covers about 100,000 acres, with two-thirds of this area in valley lands, the remainder being hills and mountain. The general valley elevation is about 3,000 feet above sea level. The east and north boundary of the ranch is the crest of a mountain range with elevations ranging up to 6,000 feet. To the west but beyond the ranch proper, lies a range rising to nearly 10,000 feet elevation, and the ranch takes drainage from all of these mountain systems. The main drainage is an arroyo, dry probably 80 per cent of the time. This arroyo is today a series of canyons ranging in depth up to 40 or 50 feet, and in width from 50 to 1,000 feet with vertical sides. It will meander up the valley for miles, gradually getting shallower until it becomes part of the general valley floor with no defined channel. The valley floor in the form of an uncut fan may then extend for several miles and an arroyo again start in definite form to carry on upstream. There may be a succession of such arroyos and fans. Most of the side washes have begun to cut deep arroyos for themselves and the process is ruining the entire valley floor, lowering the water table and furnishing, through undermining vertical banks, hundreds of tons of silt to be carried down with each flood. There is very little grass and browse cover over most of this range, but a great deal of mesquite, creosote bush, greasewood, and cactus, especially on the finger ridges between side drainages. As the elevations increase, the vegetation changes. When the elevation is more than 6,000 or 7,000 feet the vegetation consists of fair stands of pine, fir, and various grasses.

Most of you are accustomed to working with a more or less dense vegetal growth, with crops easily grown to form control cover; with forest cover; with precipitation somewhat distributed throughout the year; with land having a decent economic value. But the range engineer may have grama, sacaton, or some other of the bunch grasses, weeds, and browse—seldom in a turf as in your pastures and meadows; and to get this growth takes water, if it can be obtained, and very close control of grazing. There is forest cover only in the higher altitudes. When there is precipitation, this usually occurs as sporadic cloudbursts during a limited season. As the range engineer looks over the great open spaces he wonders, can I afford to spend anything, even one thin dime an acre, for any erosion-control works?

Most agricultural engineers in soil conservation work have more or less accurate and reliable precipitation records which have been in the making for years; but the range man has records for possibly only two or three years, and these may have been drought years. I believe that until the last few years there were but two or three rain-gage stations in Arizona, and Arizona is a pretty big state, so the engineer starts off with approximations or assumptions as to his runoff.

The runoff from the steep mountain slopes is terrific and has accumulated quantity and velocity by the time it reaches the talus slopes and valley floors where the real erosion problem begins. These rapid and sporadic or localized flows, as they tear along, pick up silt, gravel and rocks, to distribute over valley floors or irrigated lands and in reservoirs.

In the old days, before the six-shooter came into the Southwest, most of the country was more or less covered with native grasses which prevented sheet erosion and filtered out flood loads. By spreading out the water they benefited the grass growth and at the same time minimized the gully or arroyo formations. But the six-shooter changed all this. Cattle came in thousands and ate off the grass and browse cover; erosion became accelerated until today the range, which in the old days probably supported one animal to 20 acres, will hardly carry one animal unit per 100 acres. This denudation of the range is probably the primary cause of the present eroded condition, both sheet and arroyo, in the Southwest.

Now to attack the problem of soil conservation in this land of open spaces and continual blue sky. Please remember two things: The economic value is so low that very little money can be spent, and basic information necessary for computation of runoff is woefully lacking. So to make his few cents accomplish the most benefit, the engineer joins forces with the range expert. Even with the low precipitation, the native grasses will come back in a comparatively short time if grazing off of these grasses can be stopped. To gain absolute exclusion of grazing would upset an entire industry. Grazing of stock, therefore, is so regulated that cattle will continue to thrive and yet permit the grasses to live and increase. Range management, therefore, is the first and foremost means of controling erosion.

There are two mechanical features involved before grazing control can be effective, water and fence. As there are few or no live streams, water for cattle is gained by the building of stock tanks or ponds and by drilling wells, but the latter, while the most effective, are usually so expensive as to be out of the question. To control properly the roaming activities of cattle while grazing, one stock tank will be needed for an area of about 12 to 15 square miles of range. As most of the valley floors are of alluvial origin the location, design, and construction of these dams for stock ponds becomes a question of major importance. Good natural sites may be found for stock dams, but these locations may be such as practically to nullify control. Soil types are a greater factor than in dams in other parts of

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Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Urbana, Illinois, June 24, 1937.

Author: Inspecting engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

the country. Geologic formations are of less importance. These dams are located, if possible, where they will also act as the control structure for the active head of a gully or arroyo. Dams are designed so that the flood waters are the medium for filling the tanks, and if the dam is in a fairly flat valley, the spillway is designed to act as a spreader to distribute the excess flood water through brush, furrows, or other percolators over as large an area as possible. It thus affords flood irrigation that helps form a meadow of native grasses, which thereby fulfill their original purpose of acting as strainers for silt carried in suspension.

In the mountains the location and construction of dams is usually not such a problem. Foundations and construction materials are usually at hand. The spillways constructed are of the overfall type or a selected natural site when the rocky canyon sides can be adapted.

The second major requirement is proper fencing of the ranch. Exterior or boundary fences are of primary importance as a means of preventing trespass, which would overload the range with cattle from other ranches. The ranch may be divided into pastures by interior fences or simply have drift fences to turn the cattle back from certain areas. Fencing is no small problem with the range engineer, with often from 50 to 100 miles of fence on one ranch. Ranch boundaries are usually in the most inaccessible locations, such as along a mountain crest.

In these items of management, stock water, and fencing, we have used weapons of attack that are within reach of any rancher. The growth of new cover which has resulted in the past two years where these three forces have been in effect, is noteworthy.

Along with the three primary items of control, the range engineer must consider and attack the flood runoff from both mountains and plains. Here again the range engineer is faced with the fact that he cannot control this flood water as he desires. It is owned, through priority rights, by farmers scores of miles down the watershed. Remember that this engineer has little or no data to work with. You are accustomed to building a diversion structure above farmed lands to handle runoff from perhaps fifty to several hundred acres of rolling or hilly lands. Multiply this acreage a hundred times, then stand the area on edge and you have the range engineer's simple problem. To divert the water is possible, but uneconomical.

The usual, and so far the most successful, attack by the Soil Conservation Service is to locate a point in the valley where a large earth dam is feasible and where there is sufficient valley width to be able to spread excess water for revegetation. Here a retention dam across the valley or arroyo is built with a crest height so that the structure will extend as far as possible across the valley floor. Beyond the arroyo itself the structure is simply a large earth dike. Through this dike at strategic points, weep openings are cut to allow the water to distribute or spread over the range land below and either dissipate through percolation or again enter the arroyo at low velocity. These weeps are faced with either masonry or riprap, to prevent cutting of the dike itself. It may be necessary at various points below these weeps to build low brush spreaders or percolators to further distribute the flow. Also, in many soils, lister or single-bottom plow furrows will greatly add to this dispersion and percolation.

In water courses closer to the mountain slopes, spur dikes of various construction are used to intercept and spread part of the torrential flow. In main arroyos large earth detention dams are built, using plain or drop-inlet culverts to control outflow, to hold silt, and to build up the channel grade above the structure. But this type involves too great a cost for the local rancher, and it becomes a national problem to be handled by some state or federal agency. To date very little actual work on a large scale has been done on these main arroyos. Studies are still under way as to the best and most economical attack, whether it is more feasible to begin at the mouth of a main drainage and work upward, gradually building up the stream to original conditions, or to work from the little waters and come downstream. As bottom erosion in most arroyos becomes so rapid as you go towards their source, it is felt that if control measures are applied upstream first, that there is always the danger of losing works through undercutting. In a few more years the range engineer will be able to give you a paper on this problem of erosion control with definite plans and conclusions. In agricultural engineering he is as much of a pioneer as were his forefathers when they moved across the plains 100 years ago.

Choice of Power a Problem for Engineers

OBVIOUSLY, an engineer must understand where and when to use any and all kinds of power. He must decide what type of power is most economical and satisfactory to use for any particular job.

Patently, there are many kinds of work that can be done only by mechanical means. Under many conditions machinery can do work at less cost than any other way.

Everybody knows that dynamite is an explosive. But comparatively few think of dynamite as a source of power, such, as steam or electricity. Only a few years ago, even engineers were too frequently prone to consider the use of dynamite only as a last resort. Manual labor or machinery was the first thought, as a rule, when a job was to be done.

Engineers now recognize the fact that dynamite represents concentrated power, and that it is all potential power. To make the tremendous power of dynamite available requires only proper loading and the detonation of the explosive with a blasting cap. There is no need for gears, pulleys, wheels or any of the other appurtenances of mechanical equipment. In short, the power provided by dynamite is "direct" power.

Dynamite offers the further advantage of unit power, which can be multiplied as many times as may be desired. On the other hand, the power of dynamite, of course, is not a continuous form of power, such as that of an engine or a motor. But there is no need for the action of dynamite to be continuous for the many purposes to which the explosive is applicable.

Usually, investment in dynamite is made at the time the explosive is to be used, with the result that there is no "overhead," such as interest. Maintenance cost and depreciation charges are obviated.

Another important consideration is that dynamite is extremely mobile. While there is transportation cost to move dynamite to the work to be done, it does not have to be removed after the job is completed.

More frequently than is generally realized, dynamite can be used in conjunction with machinery and at considerable savings in cost and time.

By L. F. Livingston, in the "Agricultural News Letter" of E. I. du Pont de Nemours and Co.

What Agricultural Engineers Are Doing

FROM THE USDA BUREAU OF AGRICULTURAL ENGINEERING

FOLLOWING inspection of sweet potato harvesting operations in Delaware and Virginia on September 23 and 24, G. A. Cumings and W. M. Hurst reported that the cooperative fertilizer placement experiments indicated fertilizer should not be placed near the sweet potato plant, the best location being about 5 in to each side of the row and 5 in below the soil surface. In harvesting, the sweet potatoes are plowed out with a common walking type turning plow or with a slatted moldboard plow. For certain varieties which require specially careful handling, a lifting blade is drawn under the potatoes to loosen them, after which they are pulled up with the vines.

In mid-October Mr. Hurst and George Stafford observed the different methods of harvesting sweet potatoes used at the Laurel Starch Plant. Field trials with several types of harvesting equipment are being made to determine the most practical methods where mechanical injury to the potatoes is not a serious objection.

* * *

L. G. Schoenleber, with the assistance of D. B. Eldridge, is constructing a special fertilizer-grain drill to be used in fertilizer placement experiments with soybeans and small grains. Double-disk furrow openers will be installed as fertilizer depositors and special sugar beet shoes with press or gage wheels will be employed to obtain uniform coverage of the seed at shallow planting depths.

* * *

According to Claude K. Shedd the crop produced on the corn production machinery plots at Ames, Iowa, is the best grown since the project was started. The machines and cultural practices under test have been tried under a variety of conditions during the last four years. Weather was unusually dry in 1934 and 1936. In 1935 there was excessive rainfall in June. In 1937 growing conditions have been favorable during the entire growing season.

* * *

E. M. Dieffenbach reached Logan, Utah, on September 29 to inaugurate a study of weed control in cooperation with other federal bureaus and the Utah Agricultural Experiment Station. Two field experiments in weed control were established in Utah, one on Canada thistles at Heber, and the other on sow thistles at Vernal. On October 2, Mr. Dieffenbach made a field trip with the Utah Section of the American Society of Civil Engineers.

* * *

Lewis A. Jones, Chief, Division of Drainage Investigations, inspected willow bank protection work at Buffalo, New York. Several years ago willow poles were laid in shallow trenches up the bank of the stream with the butts below the low-water elevation and the tops practically flush with the top of the bank. The poles were laid during the dormant season and were spaced about 4 ft apart. They sprouted along their entire length and now, after a period of four years, form a dense mass of vegetation that amply protects the bank against erosion at bends.

* * *

In connection with the CCC work, D. A. Isler has developed a double-drum winch equipped with a 25-ft boom and scraper suitable for mounting on the bed of a truck. It has proved satisfactory for cleaning out and deepening drainage ditches too small for dragline operation. Plans are being made to construct a number of these units for use by the CCC camps.

* * *

The following work accomplishments is reported for September by the 44 CCC drainage camps; 4,424,588 sq yd clearing, requiring 29,964 man-days; 2,161,787 cu yd excavation and embankment, requiring 25,521 man-days; 37,385 ft (lineal) tile reconditioning, requiring 4,106 man-days; and 15,761 man-days used on structural and miscellaneous work. A 12 per cent reduction in the Central District in available enrollees over the previous month occurred, due principally to the approaching close of the enrollment period on October 1, when many of the enrollees received discharge to seek or assume employment in private industry.

Two drainage camps, one at Kokomo, Indiana and the other at Eldred, Illinois, were closed on October 1 in line with the general reduction in the CCC program, leaving 32 camps in active service in the Central District.

* * *

The work of inspecting snow courses, placing markers, relocating courses and establishing new ones, supervising the construction of shelter cabins, and conferring with numerous forest supervisors and other cooperators concerning the snow survey measurements during the coming winter was continued by J. C. Marr, L. T. Jessup, R. L. Parshall, and R. A. Work. Arrangements were also made for weekly reports on snow, road, and weather conditions in certain areas where winter sports are popular, these reports to be broadcast for the information of the public.

Early in the month Mr. Marr attended the annual meeting of the Western State Engineers at Helena, Montana, where he discussed the snow survey work in western Montana with representatives of the Geological Survey and the Montana Experiment Station. Later, in company with representatives of the Weather Bureau and the Water Resources Branch of the Geological Survey, Mr. Marr participated in setting up a project in Yellowstone National Park, involving snow surveying, meteorological measurements, and stream gaging.

* * *

Development and calibration of a soil moisture indicator are being carried on by R. B. Allyn. The aim is to perfect an instrument that will quickly show in the field the soil moisture stress under which a particular orchard block or crop is functioning. A preliminary survey of all soil represented in the present orchard soil moisture control project of thirty separate blocks at the Medford experiment station, indicates that the device will work satisfactorily on soil types ranging from loam to clay adobe. The instrument will be used in the 1938 soil moisture control project.

* * *

After inspection of irrigation practices in the vicinity of Spearfish, South Dakota, Leslie Bowen reported that distribution of water is one of the larger problems there. Water is diverted from Spearfish Creek to 8 separate ditches by means of rock and brush dams. Because facilities for measurement are lacking little is known about the flow of the creek proper or the amount of water diverted to the several ditches, except that during periods of limited water supply the lower ditches are dry. Each ditch takes water at such time and in such amount as users on the ditch deem necessary, with the result that upstream users sometimes get all the water. Mr. Bowen suggested the water users begin taking records of flow of the main creek, that they install suitable structures for diversion and for measurement of the flow in the various ditches, and that they select a watermaster or river commissioner.

* * *

W. W. McLaughlin left Berkeley October 7 for Washington, D. C., on a special assignment that will probably keep him until the first of next year. En route he attended the annual meeting of the National Reclamation Association at Casper, Wyoming, October 12-14, where he delivered an address on "The Rehabilitation of the Great Plains and Water Conservation." Mr. McLaughlin stressed the need for a permanent agriculture, achieved by a proper coordination of water, soil, and human factors. Sparser population of the Great Plains and concentration of settlement along the water courses was recommended.

Contributions Invited

All public-service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new development in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

From Texas

MANY agricultural engineers will have a particular interest in a new bulletin, entitled "Machine Placement of Fertilizer for Cotton" (Bulletin No. 548), just issued by the Texas Agricultural Experiment Station, College Station, which was prepared in cooperation with the U. S. Bureau of Agricultural Engineering, the National Fertilizer Association, and the Joint Committee on Fertilizer Application. Two of the three authors of this bulletin are H. P. Smith, chief, division of agricultural engineering, and M. H. Byrom, assistant agricultural engineer, Texas Agricultural Experiment Station.

PROGRAM — FALL MEETING

American Society of Agricultural Engineers

The Stevens Hotel, Chicago — November 29 to December 2, 1937

Monday, November 29

10:00 a.m.-12:30 p.m.—Executive Group Meetings

A—Council—P. D. Room No. 8

Other group meetings by arrangement

2:00-5:00 p.m.—Executive Group Meetings

A—Jury of Awards—P. D. Room No. 8

Other group meetings by arrangement

8:00 p.m.—Committee and other Group Meetings

A—Executive Committee, Midwest Building Plan Service—P. D. Room No. 10

Tuesday, November 30

9:30 a.m.-12:00 m.—Two Concurrent Sessions

A—POWER AND MACHINERY SESSION

(South Ball Room)

Presiding: *F. W. Duffee,* chairman, Power and Machinery Division

PAPER: "Farm Tractor Fuel Trends"— *C. E. Frudden,* chief engineer, tractor division, Allis-Chalmers Mfg. Co. (25 min)

PAPER: "Distillate as a Tractor Fuel"—*E. L. Barger,* assistant professor of agricultural engineering, Kansas State College (25 min)

PAPER: "Fuels as We Have Found Them"—*Carlton L. Zink,* engineer in charge of the Nebraska tractor tests, University of Nebraska (25 min)

B—FARM STRUCTURES SESSION

(West Ball Room)

Presiding: *Miss Ruby M. Loper,* chairman, Committee on Farm House Standards and Design

PAPER: "Developing a State Program for Farm and Home Building"—*Deane G. Carter,* professor of agricultural engineering, University of Arkansas (20 min)

PAPER: "Remodeling Possibilities for Farm Homes"—*H. E. Wichers,* associate professor of architecture, Kansas State College (20 min)

PAPER: "Unit Equipment for Farm Kitchens, Laundries, and Work Rooms"—*Miss Ellen Pennell,* managing editor, "The Country Home" (20 min)

PAPER: "Progress of Temperature Studies of Four One-Room Houses"—*J. W. Simons,* junior agricultural engineer, U. S. Bureau of Agricultural Engineering, and *F. B. Lanham,* research agricultural engineer, University of Georgia (20 min)

2:00-4:30 p.m.—Two Concurrent Sessions

A—POWER AND MACHINERY SESSION

(South Ball Room)

Presiding: vice-chairman, Power and Machinery Division

PAPER: "Rating Tires for Tractor Performance"—*J. W. Shields,* manager, farm tire department, U. S. Rubber Products, Inc. (20 min)

PAPER: "The Effect of Tire Sizes on Tractor Efficiency"—*R. H. Wileman,* assistant in agricultural engineering, Purdue University (15 min)

PAPER: "A New Farm Transportation Unit"—*F. W. Duffee,* professor of agricultural engineering, University of Wisconsin (15 min)

PAPER: "Some Dynamometer Tests of Tracks and Rubber"—*W. A. Harper,* superintendent of proving grounds, Caterpillar Tractor Co. (15 min)

B—FARM STRUCTURES SESSION

(West Ball Room)

Presiding: *K. J. T. Ekblaw,* past-chairman, Farm Structures Division

SYMPOSIUM—"Application of Steel in Farm Structures"

(a) "Structural Steel Units in Building Construction"—*R. H. Driftmier,* professor of agricultural engineering, University of Georgia (15 min)

(b) "How Agricultural Engineers Can Help Farmers in Selecting and Using Galvanized Roofing"—*Carl L. Cue,* fence department, United Cooperatives, Inc. (15 min)

(c) "Field Tests of Zinc-Coated Metals"—*Russel Passano,* American Rolling Mills Co. (15 min)

(d) "Electrogalvanizing of Wire and Sheets"—*L. H. Winkler,* metallurgical engineer, Bethlehem Steel Co. (15 min)

(e) "Potentialities for Steel in Barn Construction"—*E. D. Anderson,* agricultural engineer, Republic Steel Corporation (15 min)

7:30 p.m.—Continuation of Farm Structures Session

(South Ball Room)

(f) "Training for Better Farm Fence Building"—*F. J. Reynolds,* manager, agricultural extension department, American Steel and Wire Co. (15 min)

(g) "A New Type of Dairy Barn Construction"—*F. C. Lewis,* associate professor of agricultural engineering, Purdue University (15 min)

8:00 p.m.—Round Table Conferences

Wednesday, December 1

9:00-11:00 a.m.—Two Concurrent Sessions

A—JOINT SESSION:

Power and Machinery Division, Soil and Water Conservation Division, and Rural Electric Division

(South Ball Room)

Presiding: *F. C. Fenton,* vice-president, American Society of Agricultural Engineers

PAPER: "Irrigation Systems and Their Application"—*J. P. Schaenzer,* assistant director, Committee on the Relation of Electricity to Agriculture (15 min)

PAPER: "Pumping Equipment for Irrigation Requirements"—*I. D. Wood,* extension agricultural engineer, University of Nebraska (15 min)

PAPER: "Water Transmission and Distribution for Irrigation"—*H. D. Bruhn,* University of Wisconsin (15 min)

PAPER: "Sprinkler Irrigation in Humid Sections of Oregon"—*F. E. Price,* agricultural engineer, Oregon Agricultural Experiment Station (15 min)

B—FARM STRUCTURES SESSION

(West Ball Room)

Presiding: *R. G. Ferris,* chairman, Farm Structures Division

PAPER: "Forest Products Research of Interest to Agricultural Engineers"—*R. P. A. Johnson,* U. S. Forest Products Laboratory (30 min)

PAPER: "Modern Connectors Used in Wood Construction"—*John A. Scholten,* associate engineer, U. S. Forest Products Laboratory (20 min)

DISCUSSION: *Ira D. S. Kelly,* structural engineer, Timber Engineering Co. (10 min)

11:00 a.m.-1:00 p.m.—Two Concurrent Sessions

A — SOIL AND WATER CONSERVATION SESSION

(South Ball Room)

Presiding: *T. B. Chambers,* chairman, Soil and Water Conservation Division

PAPER: "Water Conservation, Flood Control, and the Prevention of Soil Erosion in Their Relation to Highway Construction"—*W. A. French,* division engineer, highway department, State of Texas (20 min)

PAPER: "Future Trends in Roadside Development"—*Geo. B. Gordon,* associate landscape architect, division of design, U. S. Bureau of Public Roads (20 min)

PAPER: "Cooperative Highway Erosion Control Projects"—*Arnold Davis,* associate agricultural engineer (Region 4), U. S. Soil Conservation Service (20 min)

B—RURAL ELECTRIC SESSION

(West Ball Room)

Presiding: *F. E. Price,* chairman, Rural Electric Division

PAPER: "Latest Developments in Electric Fencing"—*F. W. Duffee,* professor of agricultural engineering, University of Wisconsin (15 min)

PAPER: "Problems in the Design of Electric Fence Controllers"—*H. W. Riley,* professor of agricultural engineering, Cornell University (15 min)

PAPER: "Practical Experience with Wind-Electric Plants"—*F. W. Hawthorn,* farmer, Monona County, Iowa (15 min)

PAPER: "Recent Developments in the Electric Pasteurization of Milk"—*Ben D. Moses,* associate professor of agricultural engineering, University of California (15 min)

1:00-3:00 p.m.—Two Concurrent Sessions

A—POWER AND MACHINERY SESSION

(South Ball Room)

Presiding: *F. W. Duffee,* chairman, Power and Machinery Division

PAPER: "Effects of Several Factors on the Reactions of 14-Inch Moldboard Plows"—*J. W. Randolph,* agricultural engineer, U. S. Bureau of Agricultural Engineering (15 min)

PAPER: "A Study of the Nature of Physical Forces Governing the Adhesion between Soil and Metal Surfaces"—*F. A. Kummer,* assistant agricultural engineer, Alabama Agricultural Experiment Station (15 min)

PAPER: "Results of Field Tests of Small Combines"—*G. W. McCuen* and *E. A. Silver,* agricultural engineers, Ohio State University (15 min)

DISCUSSION: Led by *I. D. Mayer,* chairman, ASAE Committee on Combine Development (10 min)

B—FARM STRUCTURES SESSION

(West Ball Room)

Presiding: *R. G. Ferris,* chairman, Farm Structures Division

PAPER: "An Analysis of the Farm Structures Market"—*G. B. Hanson,* agricultural engineer, Portland Cement Assn. (20 min)

PAPER: "Stabilized Soil As a Building Material"—*F. C. Fenton,* professor of agricultural engineering, Kansas State College (20 min)

PAPER: "A Reinforced Crib and Granary of Structural Clay Tile"—*C. T. Bridgman,* engineer, Clay Products Institute (20 min)

3:00-5:00 p.m.—Two Concurrent Sessions

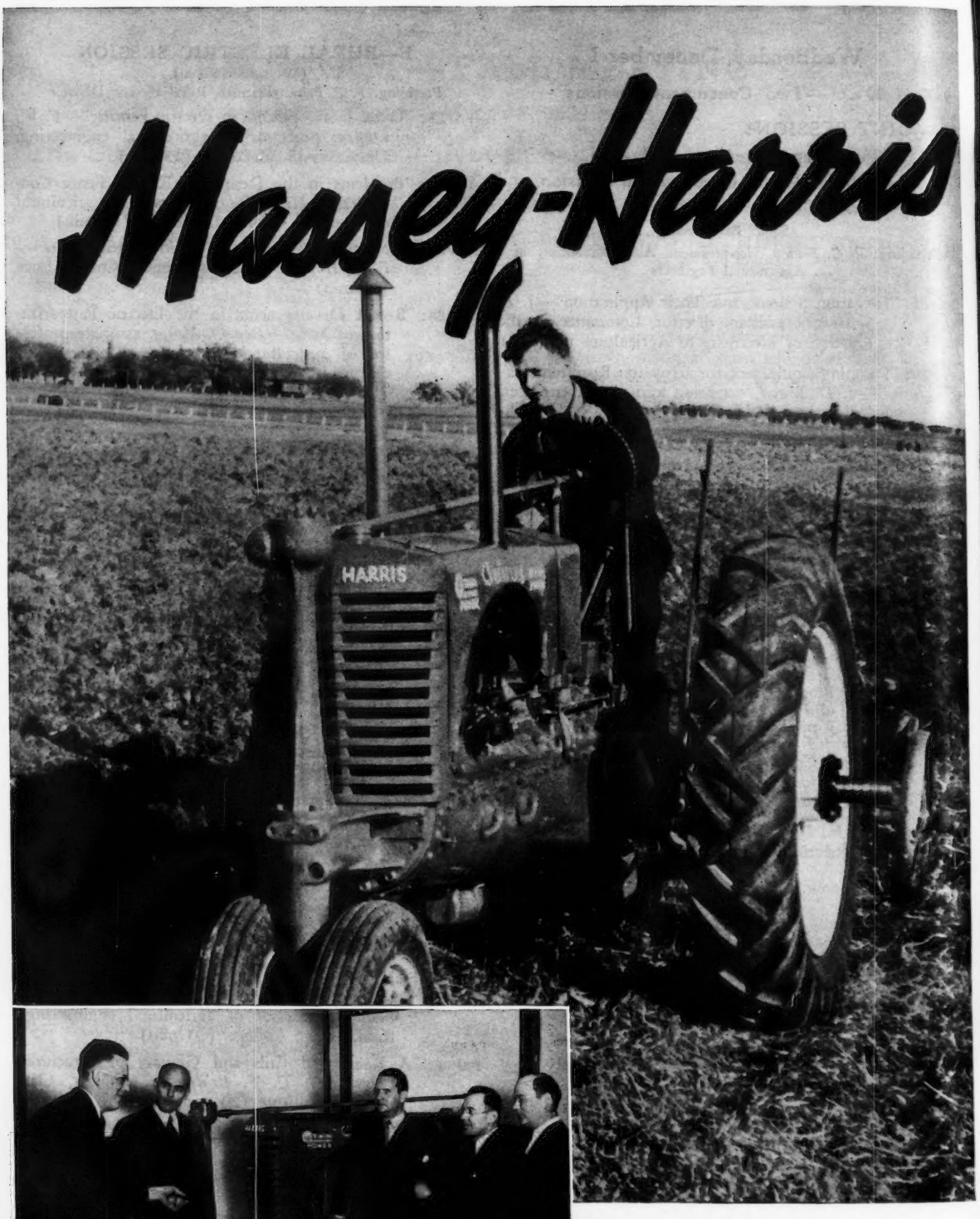
A—SOIL AND WATER CONSERVATION SESSION

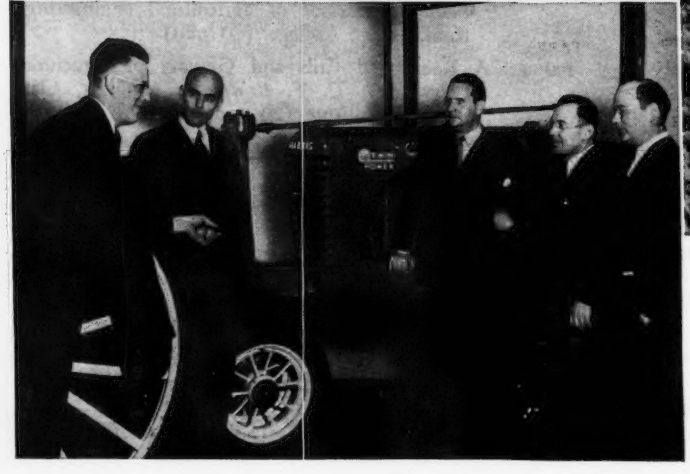
(West Ball Room)

Presiding: *C. E. Ramser* past-chairman, Soil and Water Conservation Division

PAPER: "The Erosion Control Problem of Railroads"—(speaker to be selected) (20 min)

(Continued on page 516)





(*Above*) THE NEW "TWIN-POWER" CHALLENGER AT WORK. Note the attractive, "new car" look of the 1938 high compression model. (*At left*) Massey-Harris officials look over the new "Twin-Power" Challenger. From left to right they are L. S. Pfost, Engineer in charge of Tractors; O. H. Shenstone, General Manager, Massey-Harris Co.; J. S. Duncan, Vice-President and General Manager, Massey-Harris, Ltd.; J. P. Pederson, Factory Superintendent; and L. M. Sweeney, Ass't General Sales Manager

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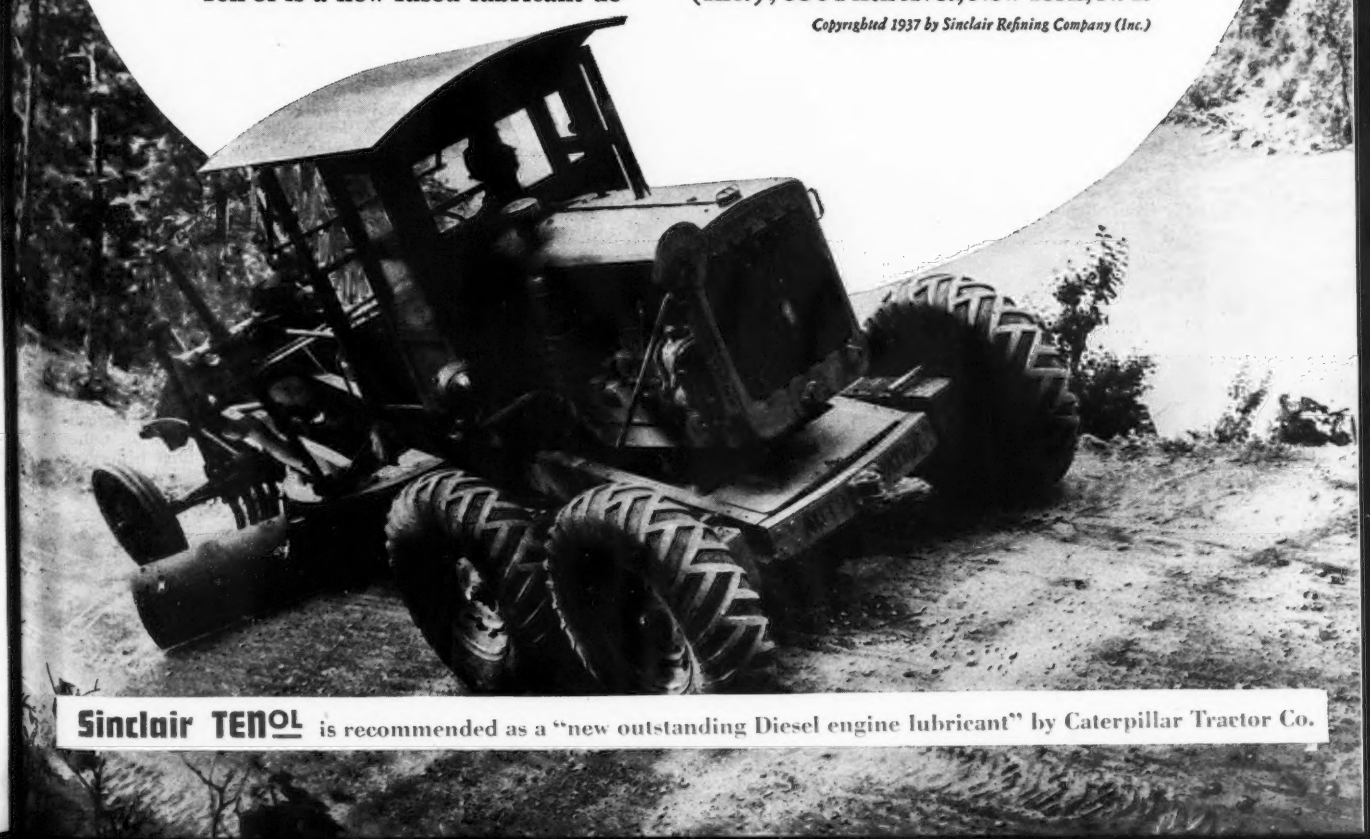


Sinclair TEN-OL is recommended as a "new outstanding Diesel engine lubricant" by Caterpillar Tractor Co.

NEWS

Necrology

EDWARD R. JONES, professor and head of the agricultural engineering department at the University of Wisconsin, passed away suddenly at his home in Madison on the morning of October 22 at the age of 55. He had been working in his yard before going to his office when he suffered a heart attack.

A native of Bangor, in La Crosse County, Wisconsin, he enrolled in 1902 as a "long-course" student in agriculture at the University of Wisconsin. Graduating in 1905, he was immediately employed in the soils department of the University and continued in the service of the University and state throughout his lifetime. He was awarded his master of science degree in 1908. In his soils work he developed a primary interest in drainage which led to his becoming a state leader and nationally known authority in this field.

Mr. Jones became a member of the American Society of Agricultural Engineers in 1914. In 1918 he and his drainage work were transferred to the agricultural engineering department, and he was named chairman of the department. He also rendered extensive service as secretary of the Wisconsin State Drainage Association, state drainage engineer, president of the National Drainage Congress, and state director of emergency conservation work. As a member of the ASAE he was active in its College Division and Farm Structures Division. He had served as a member of the Council, chairman of the Soil and Water Conservation Division, member of the College Division advisory committee, and an active cooperator in the Midwest Farm Building Plan Service. He had presented a number of papers before the Society, attended its meetings regularly, and took an active part in its discussions. He was also active locally in the affairs of the University, his church, the Wisconsin Engineering Society, Alpha Zeta Fraternity, and the Masonic Fraternity.

In addition to his reputation as an able engineer and administrator, Mr. Jones was well known as a pleasant, kindly, considerate gentleman of high character and droll humor; a friend of farmers, students, and co-workers; and a fine husband and father. He is survived by his widow, Jane Walker Jones; two sons, Richard and Edward, students at the University of Wisconsin; and two daughters, Sally and Mary.

Personals

A. W. Clyde, associate professor of agricultural engineering, Pennsylvania State College, State College, is author of Bulletin No. 343, entitled "Using the Tractor Efficiently," recently issued by that institution.

Kyle Engler has accepted an appointment to the agricultural engineering staff of the University of Arkansas, Fayetteville. More recently he was instructor in the agricultural engineering department at Iowa State College.

Paul K. Fanning, is now an apprentice engineer with the Caterpillar Tractor Company, Peoria, Ill. He graduated in agricultural engineering from Kansas State College last June.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

J. T. Ashton, chief engineer, Oliver Farm Equipment Co., Battle Creek, Mich.

Angus Banting, professor of agricultural engineering (head of department), Nova Scotia College of Agriculture, Truro, Nova Scotia, Canada.

Paul L. Battey, president and treasurer, Battey & Kipp, Inc., 231 S. LaSalle St., Chicago, Ill.

Robert P. Beasley, junior drainage engineer, Bureau of Agricultural Engineering. (Mail) CCC Camp D-4, New Madrid, Mo.

Newton B. Bodine, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp SCS-36-T, Mesquite, Texas.

David D. Clerk, chief engineer drainage section, Department of Agriculture, Parliament Bldgs., Quebec, P. Q., Canada.

Frank J. G. Duck, secretary, Rural Electrification Bureau, National Electrical Manufacturers Ass'n., 155 East 44th St., New York, N. Y.

William Kalbfleisch, department of agricultural engineering, Macdonald College, Quebec, Canada. (Mail) Box 246.

J. R. Kelly, terracer, Union Central Insurance Company. (Mail) Richland, Ga.

Paul E. Lissarrague, clerk to Secretary of Agriculture of the Republic of Cuba. (Mail) Avenida Central 10, Reparto Kohly, Marianao, Habana, Cuba.

Joe B. Richardson, research fellow, agricultural engineering department, Iowa State College, Ames, Iowa. (Mail) 320 Stanton Ave.

Howard S. Smith, assistant superintendent, The Trumbull Electric Mfg. Co., Plainville, Conn.

J. W. Sorenson, Jr., associate professor, department of agricultural engineering, John Tarleton Agricultural College, Tarleton Station, Tex. (Mail) Box 282.

Bruce K. Tice, cost department, John Deere Harvester Works, East Moline, Ill. (Mail) 431 49th St.

TRANSFER OF GRADE

Walter N. Danner, Jr., associate professor, department of agricultural engineering, University of Georgia, Athens, Ga. (Junior to Member.)

ASAE Meetings Program

November 29-December 2—Fall meeting of the Power and Machinery Division, Rural Electric Division, Farm Structures Division, and Soil and Water Conservation Division, The Stevens, Chicago, Illinois.

Student Branch News

Missouri

THE Missouri Student Branch was first to get organized and get its dues paid after opening of school this fall. Officers elected at its first meeting are Herman Hall, president; Vernon Wood, vice-president; and Norman Teter, secretary-treasurer.

A report of group activities follows:

"We have meetings every other week on Tuesday evening, lasting from 7:00 to 8:30 p.m. At the first meeting we had reports from those members who attended the ASAE meeting at Urbana, Ill. Prof. Jones gave new members an insight on the value of the Student Branch. Prof. Wooley outlined suggested plans for the year.

"On October 12 we held our annual picnic from 5:00 till 8:00 p.m. The first part was spent in a game of touch football. Weiners cooked on a grate above a hickory bark fire were served, along with cakes, salad, hot chocolate, coffee, ice cream bars, and apples. The cost was 25 cents per member. There were twenty-four members present, besides the faculty and their wives. After eating, each member gave an account of his summer's work, and told where he was from. A short business meeting was held.

"A temporary food committee, consisting of three members and the faculty was appointed for the picnic. A standing program committee consisting of President Hall, chairman, Charles Timm, Donald Brooker, and Professors Wooley and Jones, was appointed."—*N. C. Teter, Secretary.*

Georgia

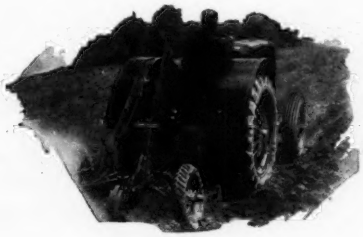
FIRST official meeting of the Georgia Student Branch of the American Society of Agricultural Engineers was held Monday night, October 11. The meeting was called to order by President C. O. Shiver.

Due to the fact that M. A. Thomas and Allen Burson are not in school this year, two new officers were elected. Milton Beckham was elected associate editor of the "Georgia Ag Engineer" to fill the vacancy created by the absence of Mr. Thomas, and Charles Rice to take the place of Mr. Burson as associate circulation manager of the "Georgia Agriculturist".

The Branch agreed to cooperate with the other clubs of the Agricultural College in sponsoring an annual dance to be called the "Harvest Ball".

R. H. Driftmier, head of the department of agricultural engineering, made an interesting and educational talk on "Agricultural Engineering as Related to Other Sciences." He also gave a brief history of the agricultural engineering department of the University of Georgia. He stated that agricultural engineering was first taught at the University of Georgia in 1909 under the name of farm mechanics, and changed to agricultural engineering in 1915.

There are 110 students enrolled for a bachelor of science degree in agricultural engineering in our department. Most of these students turned out for the Student Branch meeting and are planning to become members.—*F. L. Burrell, Scribe.*



UP GOES EFFICIENCY *and*

UP GO PROFITS

WITH "*TAILORED-TO-THE-SOIL*" GOODYEARS!

Farm Tires Designed For Any Job—Any Soil—Anywhere —Boost Profit Potential For Dealers and Manufacturers!

THIS HAS BEEN a good year for farmers—for implement dealers—for manufacturers. All have made money. Now all should be eyeing 1938 determined to make the next 12 months their best ever.

Goodyears point out one very definite way—Goodyear Tractor and Implement Tires. Farmers know them—want them—prefer Goodyears on their farm equipment as they do on their cars and trucks.

Now, with money to spend, farmers are ready to talk with your dealers about them. And now there's more to talk about than ever before.

The Goodyear line, most complete in the industry, is literally "tailored-to-the-soil"—enables your dealers to sell a *right* tire for every farm job—a tire *exactly suited* to the soil in which it will work. It gives the buyers of your equipment *maximum* traction—even bigger savings in fuel, upkeep, repairs, time and labor.

No other farm tires offer you so many profit-making advantages. Goodyears belong on your farm implements because they're better—and better known—because they lessen sales resistance—because they will make your equipment perform better, both in demonstrations and on the job.

In short—Goodyears will mean more sales—easier selling for your dealers—more satisfied users and boosters of your equipment.

THE GOODYEAR TIRE & RUBBER COMPANY, INC.
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PUT YOUR EQUIPMENT ON GOODYEARS!

THE *Right Tire* FOR THE RIGHT SOIL

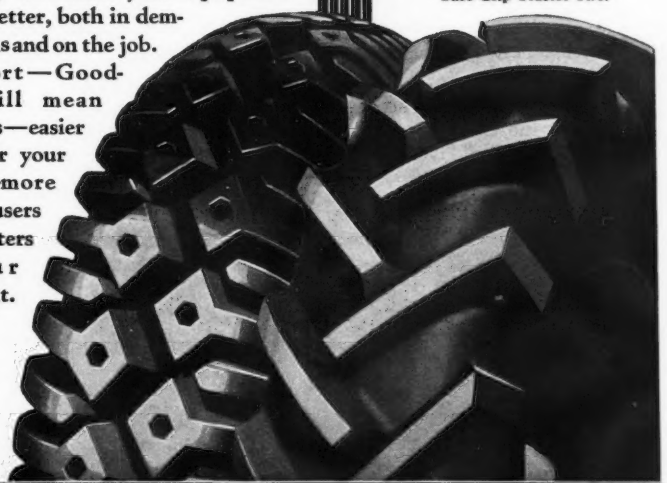
NO ONE TIRE tread is best for all types of soil or work. The deep-biting Goodyear SURE-GRIP, for example, gives maximum traction in "heavy" soils like mud, gumbo, wet clay—the more compact ALL-TRACTION tread is better in the "loose" soils like sand or loam.

Before "rubber", up to 40 different steel lug combinations were required for various soil conditions. Obviously, one tire cannot replace them all. That's why Goodyear builds the most complete line of tires in the world—a *right* tire for the soil or job.

MORE FARM TRACTORS ARE EQUIPPED WITH GOODYEAR TIRES THAN ANY OTHER KIND

(*Left*) The Goodyear All-Traction Tractor Tire.

(*Right*) The New Goodyear Sure-Grip Tractor Tire.



GOODYEAR TRACTOR and IMPLEMENT TIRES

Program — ASAE Fall Meeting

(Continued from page 509)

PAPER: "Factors Influencing the Physical and Financial Aspects of Some Major Drainage Districts"—*Lewis A. Jones,* chief, division of drainage, U. S. Bureau of Agricultural Engineering (20 min)

PAPER: "Conservation Districts"—*Dillon S. Myer,* chief of division of cooperative relations and planning, U. S. Soil Conservation Service (20 min)

B—RURAL ELECTRIC SESSION

(South Ball Room)

Presiding: *B. P. Hess,* vice-chairman, Rural Electric Division

PAPER: "Progress of the REA Program"—*Oscar W. Meier,* utilization division, Rural Electrification Administration (20 min)

PAPER: "The Romance of Radiations beyond the Visible: The Present Applications and Future Possibilities for the Farm"—*Dr. Samuel G. Hibbin,* director of applied lighting, Westinghouse Electric and Mfg. Co. (A demonstration lecture)

8:00 p.m.—Round Table Conferences

A—Rural Electrification Group

TOPIC: "Rural Electric Load Building"

Thursday, December 2

9:30 a.m.-12:00 m.—Two Concurrent Sessions

A—JOINT SESSION:

Soil and Water Conservation Division
Power and Machinery Division

(South Ball Room)

Presiding: *T. B. Chambers,* chairman, Soil and Water Conservation Division

PAPER: "Design, Construction and Preliminary Tests of the Coshocton Watercycle Lysimeters and Their Use in Hydrologic Research"—*W. D. Ellison* and *Geo. Sherman, Jr.,* U. S. Soil Conservation Service (20 min)

PAPER: "Power, Fuel and Time Requirements of Contour Farming"—*E. L. Barger,* assistant professor of agricultural engineering, Kansas State College (20 min)

PAPER: "A New Contour Furrowing Plow"—*Xzin McNeal,* graduate student in agricultural engineering, University of Missouri (20 min)

B—RURAL ELECTRIC DIVISION

(West Ball Room)

Presiding: *F. E. Price,* chairman, Rural Electric Division

SYMPOSIUM: "An Engineering Analysis of Uses for Electricity in Agriculture"—Led by *Dr. E. A. White,* director, Committee on the Relation of Electricity to Agriculture (20 min)

DISCUSSION:

(a) *E. R. Meacham,* Wisconsin Power & Light Co. (10 min)

(b) *S. B. Darnell,* Milwaukee Electric Railway & Light Co. (10 min)

(c) *C. C. Bell,* Wisconsin Public Service Corp. (10 min)

(d) *Richard Boonstra,* Public Service Co. of Northern Illinois (10 min)

(e) *F. M. Mason,* Detroit Edison Co. (10 min)

2:00-4:30 p.m.—Two Concurrent Sessions

A—SOIL AND WATER CONSERVATION DIVISION

(South Ball Room)

Presiding: *T. B. Chambers,* chairman, Soil and Water Conservation Division

PAPER: "Relationship Between Engineering and Agronomic Practices in Soil and Moisture Conservation"—*Quincy C. Ayres,* associate professor of agricultural engineering, Iowa State College (20 min)

PAPER: "Relationship of Soils to Mechanical Erosion-Control Structures"—*O. R. Zeasman,* extension agricultural engineer, University of Wisconsin (20 min)

PAPERS "Effect of Degree of Slope and Rainfall Characteristics on Runoff and Soil Erosion"—*J. H. Neal,* agricultural engineer, University of Minnesota (20 min)

B—RURAL ELECTRIC DIVISION

(West Ball Room)

Presiding: *B. P. Hess,* vice-chairman, Rural Electric Division

SYMPOSIUM: "Rural Electrification Extension Programs"

(a) *R. R. Parks,* extension agricultural engineer, University of Illinois (20 min)

(b) *D. G. Ebinger,* agricultural engineering department, Michigan State College (20 min)

(c) *A. V. Krewatch,* extension agricultural engineer, University of Maryland (20 min)

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

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* * *

Executive Office of the Society
Saint Joseph, Michigan

...*"Cletracs" carry the NICKEL ALLOY STEELS*

EXPOSED for inspection is the track frame shaft of the "Cletrac" tractor. It extends through the front of the transmission case, and over one end fits the side frame of the tractor.

Note also that the drawbar pulls from this shaft, so whether the load is being pulled, pushed or carried, all shocks and strains pass through this member.

Only the toughest and strongest materials can perform dependably at this point, hence the Cleveland Tractor Company specifies shafts of 3140 Nickel-chromium steel.

The superior mechanical properties of the Nickel Alloy Steels, their high resistance to breakage and wear, are steadily making them the standard materials for scores of highly stressed tractor parts such as gears, shafting, pinions, etc.

Hard, wear-resisting Nickel Cast Irons are also extensively used for parts subjected to wear and stress.

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THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

Agricultural Engineering Digest

THE FOREST INFLUENCE ON STREAMFLOW UNDER DIVERGENT CONDITIONS, *C. G. Bates*. Jour. Forestry, 34 (1936), No. 11, pp. 961-969. Comparing results of observations in hilly areas of southwestern Wisconsin and adjacent Minnesota with standards set up by the Wagon Wheel Gap streamflow experiments in Colorado, the author found that despite the considerable differences in climate and soil, forest and other vegetation conserved water about equally well in both regions, and that it is only when the soil is bared of vegetation that erosion becomes a serious factor. Soils covered by forest are capable of absorbing water in large amounts except when frozen or covered with ice. The forested areas of southwestern Wisconsin, by actual absorption of a part of the water released about April 1 by the melting snow, helped to reduce the volume of possible floods in the Mississippi Valley.

LOSSES OF ORGANIC SUBSTANCE IN THE SPONTANEOUS HEATING OF ALFALFA HAY, *E. J. Hoffman and M. A. Bradshaw*. Jour. Agr. Res. [U. S.], 54 (1937), No. 3, pp. 159-184. In a series of seven large-scale storage experiments conducted by the USDA Bureau of Chemistry and Soils, of which six were with alfalfa hay and one with clover, the extent of the losses of the organic substance of hay resulting from spontaneous heating was determined, and in four of these the nature of the losses was investigated. The length of storage in these experiments ranged from 1 to 7.5 mo. The samples of hay investigated contained moisture ranging from approximately 28 to 70 per cent. The moisture content of the hay immediately surrounding the samples in the mows was between the limits of approximately 10 and 60 per cent, while the average moisture content of the mows ranged from 18 to 35 per cent.

The greatest losses in organic substance as determined by loss in weight occurred in those experiments in which hay of very high moisture content was stored in a mow whose average moisture was also high. In these experiments the maximum loss was approximately 22 per cent, the minimum 4, and the average nearly 13 per cent. Losses in the individual samples varied with the respective conditions and surroundings in which these were located in the mows, particularly with respect to the free passage of air.

The losses in organic substance were much less when the hay samples approximated normally cured hay in moisture content and were stored in a mow of much lower moisture content. Here the maximum loss was 8 per cent and the average about 6 per cent.

When a relatively small proportion of the mow was of high moisture content while the remainder was very dry, the losses were also comparatively small for samples of high moisture content, the maximum loss being 8.6 per cent and the average loss less than 3.5 per cent.

The effect of temperature upon the losses of organic substance was noted. It was found that the greatest losses occurred in experiments in which the moisture conditions were favorable to heat production and in which the highest temperatures were recorded.

The results of the investigation demonstrate the seriousness of the losses in the value of hay resulting from the spontaneous heating of undercured hay, and they show further that loss in weight alone of organic substance does not indicate fully the extent of loss in value as evidenced by the fact that most of the undercured hay of those mows in which the maximum loss was 22 per cent had deteriorated into hay of very inferior quality.

The one experiment designed to show the effect of salting upon spontaneous heating failed to show any material difference in hay substance loss due to the use of approximately 1.5 per cent of salt.

Investigation showed that the losses of organic substance incurred under these storage conditions involved definitely and chiefly the fats, the sugars, and the hemicellulose group. Where the extent of losses was greatest, cellulose and crude protein also had been attacked. Lignin apparently suffered no loss.

RECENT DEVELOPMENTS IN THE USE OF ELECTRIC LIGHT TRAPS TO CATCH THE ASIATIC GARDEN BEETLE, *H. C. Hallock*. Jour. N. Y. Ent. Soc., 44 (1936), No. 4, pp. 261-279, figs. 4. The results of a study of trap lights to catch the Asiatic garden beetle, commenced in 1927 and continued each year through 1934, are reported upon. It is pointed out that because of its attraction to light this beetle has become a nightly nuisance near brightly lighted places of business and amusement on warm summer evenings. A funnel trap 4 ft in diameter with a 500-watt daylight bulb, in use from 1928 to 1931, caught as high as 188,250 beetles during a season. Laboratory studies have shown that lights of short wave length near the violet end of the spectrum are most attractive to the beetle. The results of the work with 5 types of lights and 6 types of traps used in the experiments are reported upon. Some factors, such as temperature, type of light, and construction of trap, that influence the efficiency and usefulness of traps are discussed.

THE INFLUENCE OF DIFFERENT KINDS OF LIGHT AND RADIATION ON THE DEVELOPMENT OF CROP PLANTS [trans. title], *J. Voss*. Angew. Bot., 18 (1936), No. 1, pp. 43-75, figs. 15. The author reports the results of tests of the suitability of the sodium vapor lamp, mercury high pressure lamps of different types, the neon tube, and mixed lights (mercury and incandescent lamps) as light sources for the growing of crop plants (peas, oats, and summer wheat) in the absence of daylight, and of the effects of ultraviolet light on the germination and development of wheat.

THE INFLUENCE OF RADIATION ON LIGHT AND DARK SEEDS [trans. title], *D. Meischke*. Jahrb. Wiss. Bot., 83 (1936), No. 3, pp. 359-405, figs. 27. These studies were carried out on the seeds of five species of plants previously found to germinate best in the light and eight to germinate best in the dark. The tests were made with monochromatic light of wavelengths between 2,400 and 365 mμ, using various artificial light filters, simultaneous radiation with different spectral regions, light of different intensities, green leaves as light filters, and daylight.

THE MEASUREMENT OF THE INTENSITY AND THE COLOUR OF THE LIGHT IN WOODS BY MEANS OF EMISSION AND RECTIFIER PHOTOELECTRIC CELLS, *W. R. G. Atkins, H. H. Poole, and F. A. Stanbury*. Roy. Soc. [London], Proc., Ser. B, 121 (1937), No. 824, pp. 427-450, figs. 6. The optical conditions are considered, methods of measuring the photoelectric current in the field are described, and the wavelength sensitivity curves of the photoelectric cells used are plotted for a mean noon sunlight spectrum. For ecological work the illumination in shaded sites is considered best expressed as the "daylight factor", viz, the value of the vertical component of the illumination at any spot given as a percentage of the diffuse light in the open, which is nearly a constant.

In a wood consisting mainly of *Fagus sylvatica*, a number of sites examined showed daylight factors of from 2 to 5 per cent. In such heavy shade the color factor was greatest for the deep red, and for green it was greater than for blue. There were indications of an absorption band in the near red. In such sites the radiation was about twice the daylight factor. It was found that whereas gray skylight showed an intensity maximum at 430 mμ, light in heavy shade had its maximum at 760 mμ, with a minimum at 650 mμ and a secondary maximum at 550 mμ.

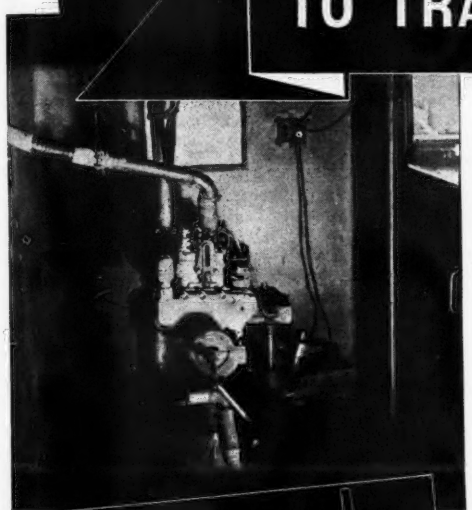
REFRIGERATION FOR THE FARM AND DAIRY, *C. A. Cameron Brown*. Oxford: Univ. Oxford, Inst. Res. Agr. Engin., 1936, pp. 51, pls. 6. This publication includes practical information on different types of small cooling plants, their methods of application, and differences in operation and running costs.

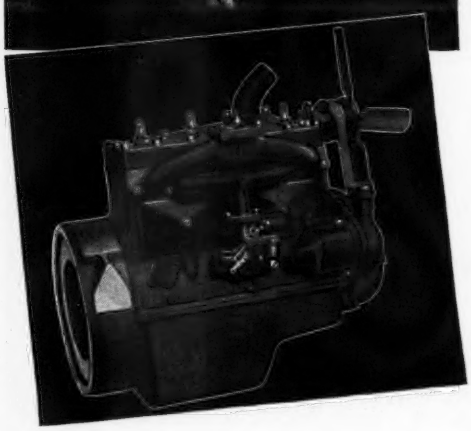
UTILIZATION OF ETHANOL-GASOLINE BLENDS AS MOTOR FUELS, *O. C. Bridgeman*. Indus. and Engin. Chem., 28, (1936), No. 9, pp. 1102-1112, figs. 4. In this contribution from the U. S. Bureau of Standards data are presented to show that blends containing ethyl alcohol have no material advantage over gasoline as motor fuels, although they can be utilized satisfactorily if full advantage is taken of the available technical information. Small percentages of ethyl alcohol in the blend are more advantageous than large percentages from the standpoints of maximum power and acceleration for minimum fuel consumption and of ease of engine starting and warming. The reverse is true from the standpoints of vapor lock and of water tolerance. A compromise may therefore be necessary from the technical standpoint in determining the composition of the blend most suitable for any particular purpose.

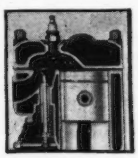
The alcohol used for blending should be essentially anhydrous in order to prevent separation of the alcohol in service. By employing a suitable blending agent the water tolerance of the blend can be markedly increased, although the ethyl alcohol used must still be practically anhydrous unless very large percentages of blending agent are employed. *(Continued on page 522)*

BY REPRODUCING DUST STORMS IN THIS ROOM

WAUKESHA *KNOWS* THE ANSWER TO TRACTOR ENGINE LIFE . . .







In tractor engine maintenance, even under normal conditions, the chief cause of expense is dust and dirt. In spite of using the best air cleaners obtainable, cylinders wear out, and excessive oil pumping with power loss quickly follows. Rings must be frequently renewed, cylinders ground, new pistons fitted and periodical general overhauling becomes necessary . . . all expensive items.

To determine the best remedy would take several seasons of widely separated field tests. But in Waukesha's dust test room the most severe dust storm can be created . . . and maintained continuously . . . to try the very heart and soul of any engine. By this accelerated test, with the most abrasive soil obtained from the Oklahoma dust bowl, the results of several seasons of normal operation are reproduced in a few hours.

By this drastic abuse, Waukesha Engine construction has been indisputably proved. *Waukesha hardened steel sleeves, after hours of grueling punishment in this dust room, showed absolutely no wear.* Pistons and rings, too, were equally free from wear. And user field tests completely substantiate these results.

Waukesha *knows* the answer to tractor engine life. Waukesha hardened steel sleeves *last ten times as long* as the best alloy irons. Dust-proof breather caps, oil retainers, filters, strainers, and every joint are specially sealed and proved. And Waukesha has applied these improvements to the simple, easy to build, easy to maintain Ricardo L-head engine. *Write for Bulletin 846.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN

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WAUKESHA ENGINES

Agricultural Engineering Digest

(Continued from page 520)

EFFECT OF PREVIOUS COLD STORAGE ON THE RESPIRATION OF VEGETABLES AT HIGHER TEMPERATURES, *C. O. Appleman and C. L. Smith.* Jour. Agr. Res. [U. S.], 53 (1936), No. 8, pp. 557-580, figs. 15. Information is presented on the results of studies by the Maryland Experiment Station on the respiratory response of various vegetables and the dahlia placed at 22 C (centigrade) following storage for various periods at 2.5 C. The respiratory intensity varied greatly in the different species immediately after harvest. In the case of carrots, beets, and turnips, the respiration rate declined steadily until the end of the respiration period, while in the potato, sweet potato, parsnip, onion, and dahlia, respiration declined rapidly at first, then more slowly until it began to fluctuate around a fairly constant average rate for the remainder of the period. The effect of cold storage on the initial respiration rate at higher temperatures varied with the different species, being very pronounced in potatoes but not detectable in carrots. Vegetables with a relatively high percentage of starch and in which there was a rapid shifting of the carbohydrate equilibrium with temperature changes were the ones that showed the greatest increase in the initial respiratory rate when transferred from low to high temperature. There was no direct correlation between the content of either total or reducing sugars and the respiration rate in the vegetables studied. The authors state the sugar that accumulates in the starchy vegetables at low temperatures is not responsible for the initial respiration on transfer to warmer environments.

ALCOHOL-GASOLINE AS MOTOR FUEL, *G. Egloff and J. C. Morrell.* Indus. and Engin. Chem., 28 (1936), No. 9, pp. 1080-1088, figs. 9. It is brought out in this contribution that alcohol-gasoline has no overall technical advantages compared to gasoline. The increased fuel consumption of a 10 per cent alcohol-gasoline blend is approximately 4 per cent higher than gasoline alone, based on both road and block tests. The improvement in antiknock value and consequent efficiency when alcohol is added to gasoline (employing suitable design and operating conditions) is less than the decrease in efficiency as measured by fuel consumption. The overall effect is an increased fuel consumption. The use of alcohol-gasoline introduces operating difficulties, especially in starting, acceleration, and vapor lock. The handling and shipment of alcohol-gasoline are difficult because of the ease with which these components separate when traces of water are introduced. It is difficult to keep water out of bulk or storage tanks, filling-station tanks, and motor car tanks. The cost of alcohol-gasoline is much higher than gasoline alone.

ALCOHOL-GASOLINE BLENDS, *L. M. Christensen.* Indus. and Engin. Chem., 28 (1936), No. 9, pp. 1089-1094, figs. 4. This contribution presents data to show that various types of alcohol blends are in common use in practically every country, the usual blends distributed commercially containing from 5 to 25 per cent of ethanol or of methanol and ethanol. Anhydrous ethanol is miscible with gasoline in all proportions; methanol ordinarily requires the addition of a stabilizer, ethanol being entirely satisfactory for this purpose.

Properly prepared alcohol blends containing not more than about 25 per cent of alcohol by volume may be used interchangeably with gasoline of equal antiknock rating. Such blends may safely be stored and distributed in modern commercial equipment. Used in this type of blend the alcohols are not substitutes for gasoline but serve the purpose of increasing the antiknock value and otherwise improving the fuel. It is on this basis that the value of these alcohols must be determined.

ENGINE PERFORMANCE WITH GASOLINE AND ALCOHOL, *L. C. Lighty and E. J. Ziurys.* Indus. and Engin. Chem., 28 (1936), No. 9, pp. 1094-1101, figs. 10. This paper deals with the power, fuel consumption, and other performance characteristics of internal-combustion engines when using gasoline and ethyl alcohol as fuels. Theoretical analysis shows ideal possibilities ranging from 2.0 per cent increase in power with gasoline compared to pure alcohol to 8.6 per cent increase with pure alcohol compared to gasoline, depending upon mixture conditions.

The water in 190-proof ethyl alcohol has a negligible effect on power but increases the specific fuel consumption about 6.6 per cent, owing to lowered heating value per given quantity of fuel compared to pure alcohol. Tests on a variable-compression, single-cylinder CFR engine, and on a 1935 Chevrolet engine, under various conditions show a small average increase in power (not much more than experimental error involved) in favor of the 190-proof alcohol. However, the specific fuel consumption with 190-proof alcohol is about 60 per cent higher on a weight basis and about 50 per cent higher on a volume basis than with gasoline.

ANALYSIS AND CONTROL OF LANDSLIDES, *R. G. Hennes.* Wash. Engin. Expt. Sta. Bul. 91 (1936), pp. 57, figs. 17. The purpose of this bulletin is to develop, in outline, an applied science of landslide control. The approach to this goal consists of (1) investigation of the nature of the shearing strength of soil, (2) investigation of the load conditions which result in exceeding this strength, and (3) application of the theory to the practical problems of analysis and control.

Part 1 deals with friction and cohesion, part 2 with the computation of the stability of slopes, and part 3 with the actual occurrence of landslides. The principles thus developed are then applied to the selection of proper methods of control. A method for determining the proper spacing of piles is developed, and methods are suggested for the design of works for drainage of gravitational and of capillary water.

It is pointed out that the application of new methods to problems connected with landslides has become possible through the development of tests to measure the physical properties of soils. To a large extent the efficiency of landslide control must depend on the accuracy with which the properties of soil have been determined for the individual case.

"ELECTRIC POWER—HOW TO OBTAIN IT AND HOW BEST TO USE IT", *M. M. Harvey.* [Rothamsted Expt. Sta., Harpenden] Rothamsted Confs. No. 21 (1936), pp. 8-41. The general purpose of this paper is to indicate how English farmers who are within reach of a public electricity supply may obtain the greatest benefits for their outlay of capital and to point out the general trend of electric farming development as related to the various types of farms.

Wiring and motors are briefly touched upon in their technical aspects, and general information is given on rates with particular reference to reasons for variations. The types of farms using electricity are tabulated with some specialized applications, and the various appliances are discussed at greater length. Other sections deal with private plants, the verdict of farmers already using electricity, some details of actual installations, tables of running costs, and other data collected from various sources and authorities.

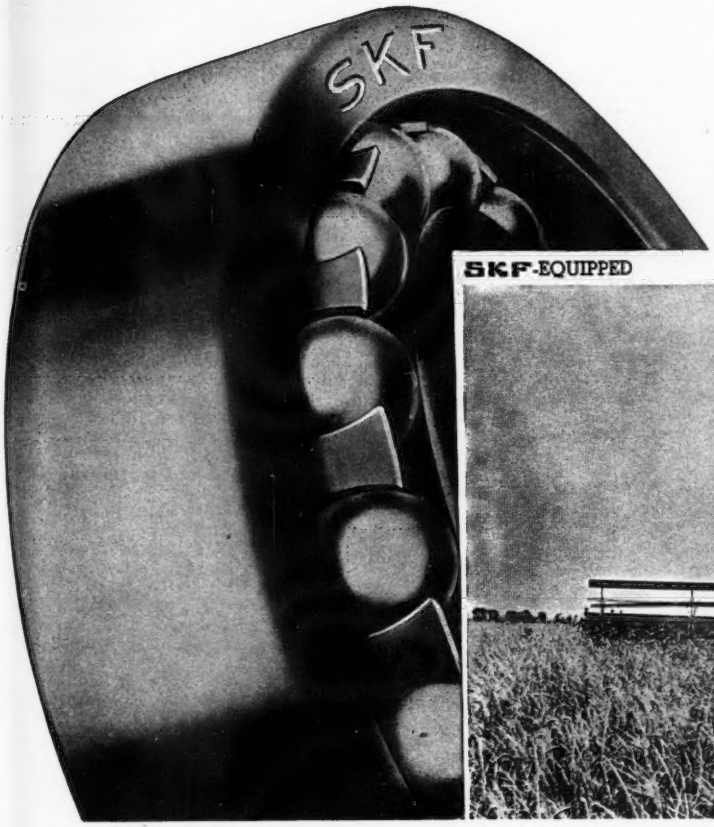
ROTHAMSTED MEASUREMENTS COMPARING FUEL AND ELECTRICITY AS A SOURCE OF POWER, *G. H. Cashen and B. A. Keen.* [Rothamsted Expt. Sta., Harpenden], Rothamsted Confs. No. 21 (1936), pp. 60-69. These investigations had for their purpose to show, for typical farming operations, how many units of electricity are equivalent to 1 gal of kerosene, gasoline, or heavy fuel oil. Threshing experiments with oats, wheat, and barley showed that for conditions at Rothamsted electricity is a cheaper form of power than fuel oil in a tractor. Feedgrinding experiments were in favor of a Diesel motor using fuel oil.

REPORT OF PROCEEDINGS OF THE SEVENTH SOUTHWEST SOIL AND WATER CONSERVATION CONFERENCE, 7. Southwest Soil and Water Conserv. Conf., Stillwater, Okla., 1936, Proc., pp. 83. These proceedings contain special reports on Progress of Soil Conservation Work in Region Four, by L. P. Merrill (pp. 5-8); The Progress Made in Wind Erosion Control in the Southern High Plains Region, by H. H. Finnell (pp. 9-11); The Outstanding Experimental Results in Erosion Control at Temple, Texas, by E. B. Deeter (pp. 12-14); Watershed and Hydrologic Studies, by C. E. Ramser (pp. 14-22); Progress in the Central Plains Area—Region No. 7, by N. E. Winter (pp. 22, 23); Soil and Water Conservation Investigations, by G. W. Musgrave (pp. 40-45); Recommendations for Research Relating to the Control of Wind Erosion, by H. V. Geib (pp. 45-51); Soil and Water Conservation on Land Utilization Projects in Oklahoma and Texas, by G. Briggs (pp. 51-54); A Study of Gully Formation and Control in Oklahoma, by H. J. Harper (pp. 54-64); The Cost of Terracing With Power Equipment, by D. G. Carter and W. C. Hulbert (pp. 64-68); The Importance of Vegetative Growth on Erosion Control, by A. E. Aldous (pp. 69-72); and Grass and Legume Studies in Connection With Pasture Improvement and Erosion Control at the Red Plains Soil Conservation Experiment Station, by H. M. Elwell (pp. 72-75).

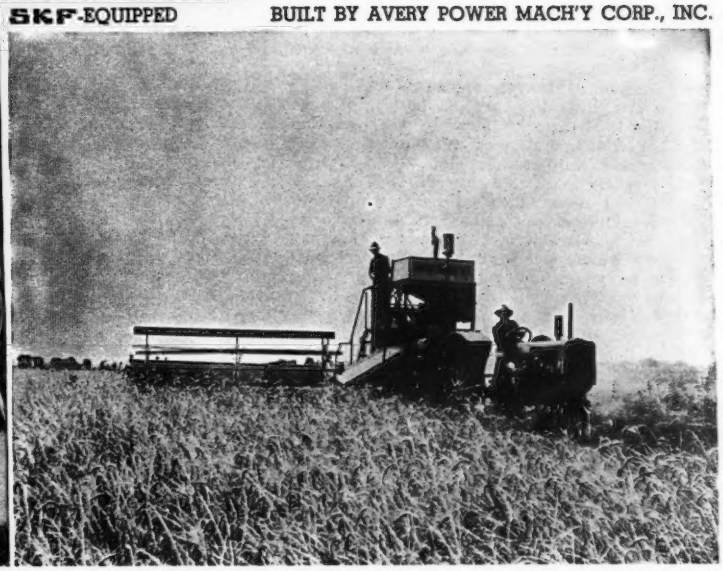
FARM WIRING, *C. A. Cameron Brown.* Oxford: Univ. Oxford, Inst. Res. Agr. Engin., 1935, pp. 32, pls. 4. This is a semitechnical discussion of different wiring systems with suggestions for the most satisfactory system for use in farm buildings.

FARM ENTERPRISE MECHANICS, *G. A. Schmidt, G. F. Henry, M. Henderson, F. J. Zink, J. D. Long, L. R. Larson, R. H. Smith, E. R. Bristol, H. O. Sampson, and F. C. Lewis,* edited by *K. C. Davis.* Chicago: J. B. Lippincott Co., 1935, pp. [IX] + 408, [figs. 602]. This is a practical treatise on construction, care, and repair of farm equipment.

(Continued on page 524)



SKF-EQUIPPED BUILT BY AVERY POWER MACH'Y CORP., INC.



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● Farmers who seek to transform acres into profits make no mistake by using this Avery Model L 12-foot Combine. Because SKF Ball Bearings keep the cylinder in its correct position both axially and radially, users are assured of prevention of cracked grain, the ability to thresh 95% of the time with only *two rows of concaves,* reserve capacity, and low power consumption.

SKF Bearings maintain initial tolerances between cylinder and concave teeth at the cylinder speed of 1100 r.p.m. Because they compensate within themselves for any shaft deflections, they will not bind or run hot. That's why the widespread use of SKF-equipped machines leads to greater profits for the men who use them.

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BALL AND ROLLER BEARINGS

Agricultural Engineering Digest

(Continued from page 522)

MECHANICS OF MATERIALS, *S. G. George and E. W. Rettger.* New York and London: McGraw-Hill Book Co., 1935, pp. XII + 483, figs. 428. This text covers the essential topics of a first course in mechanics of materials. It contains chapters on stress and strain; testing materials; tension and compression; riveted joints; torsion; simple beams, shear, and moment; stress in beams; elastic curve; stress intensities on different planes; columns; nonprismatic and special beams; and slope and deflection, moment area method, theorem of three moments.

STUDIES IN POWER FARMING. Oxford: Univ. Oxford, Agr. Econ. Res. Inst., 1936, pp. 77, figs. 2. This contains two studies.

Part 1, Mechanized Corn-Growing, by A. Bridges and H. Whitby (pp. 7-48), deals with the organization of a number of large mechanized grain-growing farms, which were the subject of a survey made in the autumn of 1934. As a survey of the same farms, and some additional farms which properly come within the definition of mechanized grain-growing farms, is now being repeated, this report is in the nature of a preliminary statement, confined mainly to an account of the facts relating to the organization for production of the farms in question. The report is concerned with 28 English farms where the combine harvester-thresher was in use during the grain harvest of 1934.

In part 2, The Cost of Tractor Work, by J. R. Lee (pp. 49-77), an economic analysis of the situation is presented.

HANDBOOK OF EROSION CONTROL ENGINEERING ON THE NATIONAL FORESTS, *E. W. Kramer, A. L. Anderson and M. B. Arthur.* U. S. Dept. Agr., Forest Serv., 1936, pp. VI + 90, figs. 72. The purpose of this handbook is to serve as a guide in carrying on erosion control work in the national forests. It emphasizes the control measures which apply to comparatively undeveloped or forested types of land rather than those for agricultural or cultivated areas. The greater part of the handbook deals with the design and construction of engineering structures which have proved practicable for erosion control work, and with the considerations which affect the choice and use of these structures. It contains chapters on the erosion problem on national forests, erosion control measures, hydraulics of erosion control, gully structures, estimated cost of restoring a gully, soil saving and debris dams, and miscellaneous structures.

PREVENTING SOIL BLOWING ON THE SOUTHERN GREAT PLAINS, *E. F. Chilcott.* U. S. Dept. Agr., Farmers' Bul. 1771 (1937), pp. [2] + 29, figs. 21. Tillage practices and implements used for the prevention of soil blowing are described, together with cropping practices.

ELECTRIC SOIL HEATING FOR HOTBEDS, *T. E. Hienton and J. H. MacGillivray.* Indiana Sta. Circ. 226 (1936), pp. 16, figs. 9. The results of studies are briefly reported which showed that the use of soil-heating cable for heating hotbeds electrically is superior to the individual heater from the standpoint of ease and cost of installation and cost of operation. Cabbage and tomato plants will germinate in less time and the plants grow faster in hotbeds with the cable installed on the surface of the soil, or in the soil and air, or at a depth of 3 in in the soil than in those where the cable is 6 in below the soil surface. Records of 35 electrical hotbeds operated in the state from 1931 to 1936 showed a variation in consumption from 0.22 to 3.6 kwh per 3x6-ft sash per day. Of the entire group, 8 used less than 1 kwh per sash per day, 12 used from 1 to 1.5, 7 used from 1.5 to 2, 4 used from 2 to 3, and 4 used more than 3 kwh. Covering hotbeds at night reduced the amount of energy consumed, and the use of cinder insulation under and around the beds showed a saving of 20 per cent in amount of electricity used. Banking the frames with soil and fitting sash tightly to the frames likewise reduced energy consumption. Control of heating units with thermostats showed no advantage in saving of electric energy over manual control, but eliminated the necessity for close personal attention to temperature regulation.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE ILLINOIS STATION. Illinois Sta. Rpt. 1935, pp. 126, 127, 220-241, figs. 2. The progress results are briefly reported of investigations on factors affecting the pulling power of horses and mules; use of electricity in agriculture; farm sewage disposal; tractor lubrication; trash covering equipment for plows; soil erosion control; combine harvesting; harvesting and storage of artichokes; artificial drying of corn, forage, and other farm products; stationary spraying; apple washing; gas production from farm wastes; and farm building design.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW JERSEY STATIONS. New Jersey Stas. Rpt. 1936, pp. 25-27. The progress results are briefly presented of investigations on poultry houses, sweetpotato storages, and effect of tree roots on drain tile.

IMPROVED POULTRY HOUSING AND EQUIPMENT, *D. C. Kennard and V. D. Chamberlin.* Ohio Sta. Bimo. Bul. 185 (1937), pp. 65-72, figs. 3. This article offers some current ideas and suggestions generally applicable to specific plans for various types of housing and to older houses which may need to be modernized.

UTILIZATION OF TRACTORS AND COST OF TRACTOR POWER ON GRAIN FARMS (Northern Great Plains and Pacific Northwest, 1933), *R. S. Washburn and R. S. Kifer.* U. S. Dept. Agr., Bur. Agr. Econ., 1936, pp. [2] + 31, fig. 1. The purpose of this mimeographed report is to show the extent to which tractors are used for farm power, the type and size of tractors in use, the kinds of work done, and the cost of using tractors on representative farms in the grain-producing sections of the northern Great Plains and of the Pacific Northwest. The study was made in April, May, and June, 1934, and for the most part applies to the crop year 1933. The field data were obtained by personal interviews with 1,674 farm operators.

It was found that for the ordinary high-wheel tractor in the northern Great Plains, fuel and lubricants constituted 44.3 per cent of the total annual cost of operating tractors, cash repairs 10.4, hired labor on repairs 0.1, other labor 1.7, depreciation 33.3, and interest 10.2 per cent. In the Pacific Northwest, the percentage distribution of the total cost for track-laying tractors was as follows: Fuel and lubricants 47.3 per cent, cash repairs 11.1, hired labor 0.3, other labor 1.5, depreciation 30.4, and interest 9.4 per cent.

In the northern Great Plains the work of general-purpose tractors amounted to an average of 458 hr per tractor per year, for ordinary high-wheel tractors 392 hr, and for track-type tractors 760 hr. The greater annual use of the general-purpose tractor as compared with the ordinary high-wheel tractor was mainly accounted for by its use in cultivating row crops. The large number of days of annual use of the track-type tractor was mainly because of the fact that this type of tractor was used almost exclusively on farms of the largest crop acreages. In the Pacific Northwest the work of ordinary high-wheel tractors and of track-laying tractors amounted to an average of 373 and 657 hr per tractor per year, respectively. As in the northern Great Plains, the lesser amount of work done annually with high-wheel tractors than with track-laying tractors was largely because of the fact that the high-wheel tractor was used principally on the small to medium-sized farms.

The distribution of tractors of different types and sizes in the northern Great Plains by hours used annually shows that 71 per cent were used 500 hr or less and 19 per cent from 501 to 750 hr, whereas only 10 per cent were used over 750 hr. In the Pacific Northwest 58 per cent of the high-wheel tractors were used 400 hr or less, 37 per cent from 401 to 800 hr, and only 5 per cent more than 800 hr annually. Thirty-one per cent of the track-type tractors were used 400 hr or less, 43 per cent from 401 to 800 hr, and 26 per cent more than 800 hr annually.

TILLAGE, PLANTING, AND HARVESTING EQUIPMENT ON GRAIN FARMS AND RATES OF DOING FIELD WORK WITH THESE IMPLEMENTS WHEN DRAWN WITH HORSE AND WITH TRACTOR POWER (Northern Great Plains and Pacific Northwest), *R. S. Washburn and D. Merrick.* U. S. Dept. Agr., Bur. Agr. Econ., 1936, pp. [2] + 51, fig. 1. This mimeographed report presents information relative to kind, size, and accomplishment of field implements on representative grain farms. The first part of the report gives numbers and sizes of field implements by type-of-farming areas. The second part shows the rates at which these implements did field work when drawn with horses and with tractors. The study was made in April, May, and June, 1934, and for the most part applies to the crop year 1933. The field data were obtained by personal interviews with 1,674 farm operators in grain-producing areas of the northern Great Plains and the Pacific Northwest.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE WISCONSIN STATION. Wisconsin Sta. Bul. 438 (1937), pp. 18-35, figs. 8. The progress results are briefly presented of investigations which are being conducted on the one-story dairy barn, by F. W. Duffee, S. A. Witzel, H. D. Bruhn, and E. C. Meyer; electric fences and pumping system for treating alfalfa silage with molasses, both by Duffee and Bruhn; electric brooders and dual-wheeled tractor trailers, both by Duffee, Bruhn, and Meyer; hay chopping and storage, by Duffee, Bruhn, Meyer, L. F. Graber, G. Bohstedt, B. H. Roche, and E. B. Hart; and erosion control by O. E. Hays and V. J. Palmer.

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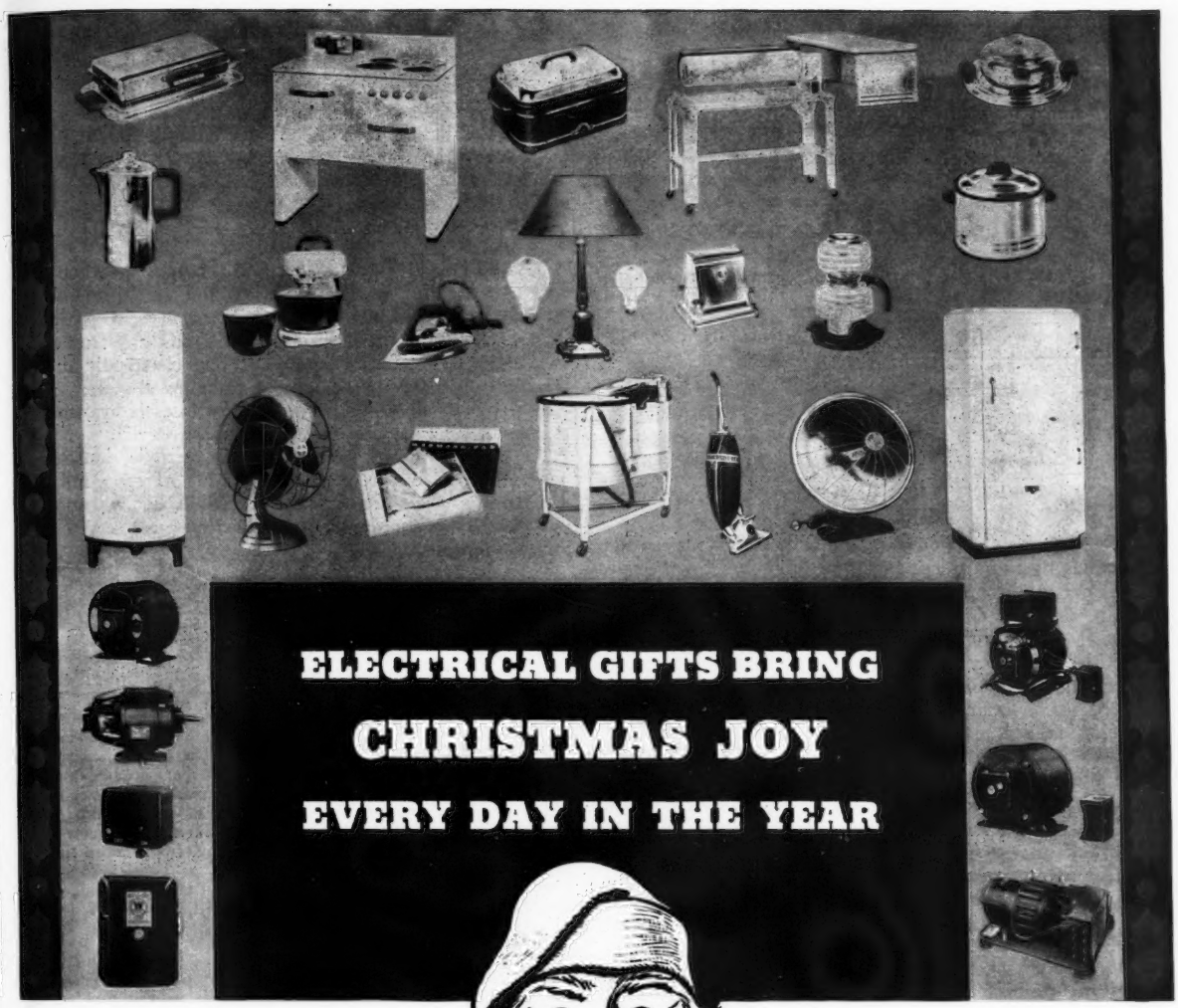

Christmas will be joyful, indeed, if families on electrified farms select electrical gifts fitted to their needs of each member.

But the deep, lasting enjoyment will come later. Think how the womenfolk will enjoy an electric Range next summer. Think of the steps they will save by having milk, butter and other perishables close at hand in an electric Refrigerator. With a Washer and Ironer, laundering will take but half the time and a fraction of the effort. Daily, a Vacuum Cleaner, Food Crafter, and other appliances will save time and add to convenience.

Outdoors, the men will get constant help from electric motors used to pump water, operate shop equipment or do any of a dozen tasks that are slow and tiresome when done by hand.

The family pocketbook will be happy, too, because of the savings in work and time made possible by Wired Help . . . the Cheapest Hired Help.

As the Christmas season approaches, why not suggest to farmers and their families, that they give gifts of lasting joy and help—electrical gifts. Your suggestion will long be remembered. J 93550

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Electricity in Fruit Farm Operation

(Continued from page 502)

Insurance	80.00	80.00
Incidentals (0.1 per cent of plant)	14.00	13.00
Total fixed charges	1875.25	1754.25
Fixed charges per bushel	10.4 cents	7 cents
Operating expense per year—		
Power for season	700.00	960.00
Labor (estimated)	100.00	100.00
Ammonia	12.75	12.75
Salt		15.00
Oil	5.00	5.00
Water		
Total operating expense	817.75	1092.75
Total operating expense per bushel	4.5 cents	4.4 cents
Cost per bushel of storing fruit filled to capacity	14.9 cents	11.4 cents

The above costs compare with a rate of 22 cents per bushel in commercial storages.

Due to the imposition of tolerance of poisonous residues on apples by the federal government, it was necessary to install washers for residue removal. At the present time we are using a large tandem washer of 150-bu per hr capacity, run by a 10 and 5-hp motor respectively. Large quantities of water are necessary, and waste water from the refrigerating plant is used when both are operating.

Fresh cider is made and sold locally at retail. By reason of being able to make it in large quantities at infrequent intervals, and keeping it under refrigeration, it is a profitable side line, as a good price is realized for the small and inferior apples of little value that go into the product.

Insect electrocutor traps are used around the packing house and storage when moths are emerging.

This season we are adding a fruit brusher for cleaning fruit from areas sprayed with non-poisonous materials, and two nailing machines for making apple boxes, increasing the electric load by 5 hp.

Summarizing our use of electricity for different purposes, the connected hp load is as follows:

For pumping water	5 hp
Spraying	60 hp
Refrigeration	63 hp
Apple washing and packing	18 hp
Cider press and filter	1½ hp
Ventilating fans and miscellaneous	2½ hp
Total	150 hp

Most of our energy use is seasonable and some of the motors are changed about for different uses, the total horsepower of actual motors on the farm is 116.

The total consumption of electricity for the 1935 season, April to April, was 76,208 kwh, at an average price of 2.51 cents per kilowatt-hour. August was the only month that consumption dropped below 2,000 kwh. October and November were the peak months, with a use of 24,748 and 12,202 kwh, respectively.

The 1936 crop was almost a failure and total consumption dropped to 28,330 kwh, bringing the average price per kilowatt-hour to 3.07 cents. Only one-fourth the storage was operated and that for a short time only.

The investment in electrically operated equipment is as follows:

Cold storage	$27,000.00
Spray plant	8,000.00
Water pumps	500.00
Fruit washer	2,500.00
Fruit sorter	1,000.00
Cider press and filter	500.00
Ventilating fans	500.00
Fruit brusher	500.00
Nailing machines	300.00
Total	$40,800.00

While our investment and fixed charges are high, we feel that we are low-cost producers and are in a position to hold our own on a competitive basis.

In conclusion, the electrification of most any fruit farm is a gradual process. The use of one electrically driven machine or piece of equipment leads to the desire for others, but the limiting factor in most cases is availability, as most rural lines are only single-phase service.

The industry has been through a serious depression, with years of overproduction and years of crop failures, and many growers are in financial trouble, but with one or two good years the demand for electric power service will increase tenfold.

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THE EVOLVING HOUSE. III, Rational design, *A. F. Bemis.* Cambridge: Mass. Inst. Technol., 1936, pp. XXXV+625, pl. 1, figs. [205]. This volume of this series contains chapters on efforts toward rational housing, what is rationalization, mass production and the house, standardization for house parts, the cube as a module, the theory of cubical modular design, applied cubical modular design, the cubical module in architectural design, rational production, patents and the cubical modular method, and social significance of the cubical modular method. It also contains appendices on rectangularity of housing, comparative cost of inclined and flat roofs, multiple openings of various sizes and their relations to symmetry in modular walls, and modular patents; and a supplement entitled Survey of Efforts to Modernize Housing Structure, by J. Burchard 2nd (pp. 327-625).

RECENT DEVELOPMENTS IN DWELLING CONSTRUCTION. Fed. Housing Admin, Tech. Bul. 1, rev. (1937), pp. 17. This report presents the approach which is being made to the problem of better construction at lowered costs, and an evaluation of the work which has been done, together with tentative conclusions as to its probable effect on the dwelling market. Brief descriptions of the different materials and methods of construction which are being tried out, together with lists of the individuals and concerns who have been engaged in such work, are also included. This includes some methods developed and used in Europe.

THE FARMER'S SHOP BOOK, *L. M. Roehl.* Milwaukee: Bruce Pub. Co., [1936, 5. ed.], enl. and rev., pp. 471, [pl. 1], figs. 247. This is an enlarged revised edition of this practical treatise.

ELEMENTS OF FOREST MENSURATION, *H. H. Chapman and D. B. Demeritt.* Albany, N. Y.: J. B. Lyon Co., 1936, 2. ed., rev., pp. 451, figs. 89. This is the second revised edition of this book. It contains chapters on the field of forest mensuration, cord or stacked measure, cubic volume of logs, the cubic volume of standing trees, the cubic volume of felled trees, the construction of local tree volume tables for cubic contents, the measurement of heights of standing trees and its application, timber estimating for cubic and cord measure, the construction of standard volume tables for cubic feet, the construction of alinement charts for standard volume tables for cubic feet, statistical measurement of the reliability of the averages obtained from samples, the boundary survey and determination of total area, the measurement of board feet in the log, construction of log rules, timber estimating for board feet by use of log rules, the construction of standard volume tables for board feet, timber estimating for board feet by use of volume tables, piece products and measurement of piece products in the tree and taper tables, the growth of trees and of stands, the age of trees and stands, yield tables for even-aged stands—their application, the construction of normal yield tables, the periodic or current growth of trees and stands, the growth of trees in height, growth of trees in diameter, growth per cent, sample plats, the growth of trees in volume, and forest survey or inventory.